Materials & Methods

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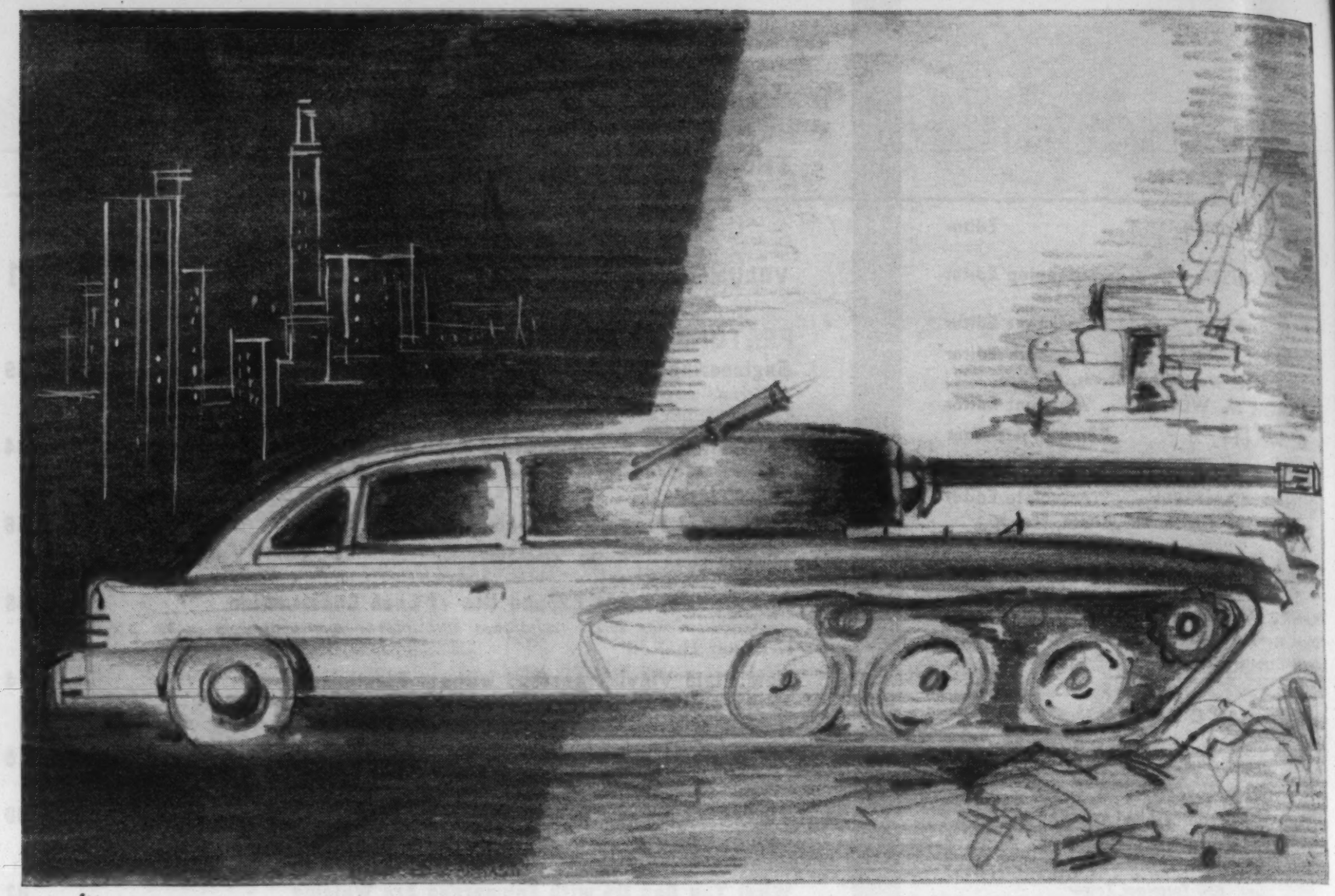

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The Materials Outlook

After months of arguing back and forth, officials of the National Production Authority have finally announced a Controlled Materials Plan to take effect on July 1. Complete details of the plan have not yet been announced, but are expected to be available at regional offices of the Department of Commerce early in May. A large-scale scramble for materials used by those industries not covered by the plan is anticipated. Many observers believe that it will take at least until Sept. 1 before the plan can work with anything approaching smoothness. July and August will be in the nature of a trial run after a period of observation.

As an example of competent materials engineering, we cite Pratt & Whitney Aircraft, which has developed a jet engine using only those materials that are available on the North and South American continents. Exhaustive tests and changes in manufacturing procedures made possible large scale replacements. The engines use less critical materials per pound of thrust than any other domestic production engine. Greatest savings were made in columbian (virtually eliminated) and cobalt and tungsten (only a trace of each used).

A new super-strength aluminum alloy is just becoming available. The new alloy is said to be 10% stronger than the strongest alloy now in use. For the time being, the alloy is being restricted to airplane builders for experimental and controlled production use. Because of the higher strength, use of the alloy will permit appreciable reductions in plane weights. This, of course, means greater speeds, greater loads and further range. XA75S, as the new alloy is termed, is in the 75S family. The higher tensile and yield strengths are attained with some sacrifice in workability. Currently, the alloy is produced as sheet plate and extruded shapes.

History is repeating itself in the steel industry. Scarcity or good scrap is causing some reduction in output and will cause worse disruptions if a greater supply is not forthcoming. The situation is so acute in some cases that steel mills are processing their own mill scrap. The potential scrap supply is great — as anyone who has seen the thousands of old automobiles in junk yards can attest — but it is not moving into the market. It will not be long before World War II scrap drives will be revived if the situation does not correct itself almost immediately.

(*Continued on page 4*)

The Materials Outlook *(continued)*

There is some hope for slight relief in the nickel situation by the end of this year if current plans are fulfilled. Inco expects to increase production by 1,000,000 lb per month late this year.

Although there have been many favorable reports on the boron-treated steels, most of the larger automobile companies are approaching them cautiously. Practically all of them are conducting exhaustive tests. In the meantime they are using the Alternate Steels (formerly N.E. steels) in increasingly large quantities.

Another shortage which will hit the inspection departments of many industries is that of x-ray films. Every rocket that is produced is checked by x-ray because voids in the charge can result in premature explosions and erratic behavior.

The production of magnesium will reach a rate of approximately 125,000 tons per year by late fall. However, the biggest easing in the magnesium field will be the completion of a modern continuous rolling mill for turning out magnesium sheet. This one mill alone will increase the country's capacity for production of magnesium sheet by about ten times.

American Can Co., in an effort to develop a can that will not require materials that might become unavailable in time of war, has produced a container that does not require tin coating over the iron sheet. Continuing research with sheet metal, enamels, solders and fluxes holds out the possibility of making a "tinless tin can" in the future. At present, the container is not a "sanitary can", used for foodstuffs, but is being used as a container for motor oil and antifreeze. The metal used is black iron sheet stock, with a coating of protective enamel, and with a plastic cement used as the seam sealer.

A can that will effect substantial savings in the amount of tin used in sanitary cans has been developed also. Here the saving occurs through use of a new low-tin solder with a tin content of 3% instead of the usual 40%. Another variation being studied would use tinned stock of the present grade with the tin electrodeposited and then flowed by induction heating, but with a tinless solder used for the longitudinal seam. The best possible combination of protective enamel, tinless solder, acceptable flux, or cement has not yet been determined, however, and the tinless sanitary can is still something for the future. The aim of continuing research is to make the container industry completely independent of foreign sources of can-making materials.

See page 7 for "Materials Control Orders"

News Digest

Controlled Materials Plan Begins in July

CMP is a plan by which the three basic metals—steel, copper and aluminum—will be allotted directly to product producers on the basis of detailed requirements, submitted in advance, for the manufacture of goods which the Government needs for the defense program.

"CMP makes it possible to authorize specific production schedules and make firm allotments of the three basic metals needed to meet, but not exceed, direct defense and defense-supporting production and construction goals—on time and in the proper quantities," Mr. Manly Fleischmann, Administrator, National Production Administration, said.

The first phase of the CMP operation will be the reporting to NPA by producers of their detailed requirements for the basic materials on forms, which will be sent to them in May. The second phase will be the allotment of the specific amounts of materials to producers starting July 1, after determination by the Defense Production Administration of the necessary production programs.

Mr. Fleischmann said manufacturers of military products, products for the Atomic Energy Commission, and certain defense-related construction projects will file their requirements under CMP regulations. Also required to file will be manufacturers of other products using steel, copper and aluminum, excepting consumer durable goods. This will be done in order that NPA can gage their needs and measure the impact of the defense program on their production, whether it is under CMP or not.

Manufacturers of consumer durable goods will not file requirements, Mr. Fleischmann emphasized, although final decisions have not been made on all items. Repair shops, he added, will not file since they will be covered by a special CMP regulation which will assure them of needed materials without application to NPA. Manufacturers of repair and replacement parts will, however, be required to file with NPA.

How CMP Operates

As in World War II, products programmed under the Controlled Materials Plan fall into two categories: "A" products and "B" products. In general, "A" products are those where the most convenient method of production authorization is vertical. Producers of "A" products get their production authorizations and material allotments from their customer. A prime contractor's customer is a Government agency. A sub-contractor's is a prime contractor or another sub-contractor.

The "B" list programs will include certain products where it is most practicable to furnish authorizations horizontally, directly to the producer. In general, this list will include certain civilian type products, industrial machinery and equipment, and components which are needed for defense. Producers on the "B" list will obtain their authorizations and allotment from their NPA Industry Div.

It is planned that after the first quarter of operations, CMP will be decentralized. In World War II it was found that in the great majority of cases CMP authorizations and allotments were best handled through field offices. Most producers will then apply to their local offices. This cuts down the paper work in Washington and saves producers time, trouble and expense.

Advantages of CMP

By means of CMP, the National Production Administration will tell producers what the Government has to have, it will furnish the timetable for getting things done, and it will give producers the authority to carry out the program. This authority is expressed in terms of an authorized production schedule to obtain and use controlled materials and a preference rating on other materials and components needed to complete the job. The authorization or allotment of steel, copper or aluminum under the Controlled Materials Plan is not a hunting license; it is a cashier's check on the known supply.

Producers affected by the Controlled Materials Plan will have plenty of time to brief themselves on procedures and regulations and be ready to operate under the Controlled Materials Plan after July 1. Forms, operating instructions and the official "B" list will be made available by May 1, 1951, so that producers coming under Controlled Materials Plan programs will have two months to prepare.

Products Coming Under CMP

The tentative list of products for which application forms will be required is as follows: Agricultural machinery; construction and mining machinery; oil field machinery; machine tools, metal working machinery and accessories, including welding and cutting apparatus; steam engines, steam and hydraulic turbines; pumps and compressors; conveyors and conveying equipment; elevators and escalators; fans and blowers, industrial; industrial trucks and tractors; mechanical power transmission equipment; heat exchangers, condensers, packaging machines, centrifugals and separators; hydraulic jacks and lubricating devices; motors and generators; switch gear and electrical control apparatus; electrical welding apparatus, including electrodes and welding rods; ships and vessels; locomotives; railroad and street cars; tractors; tin cans; fabricated structural steel products; tanks, boilers and cylinders; stamped

(Continued on page 10)

News Digest

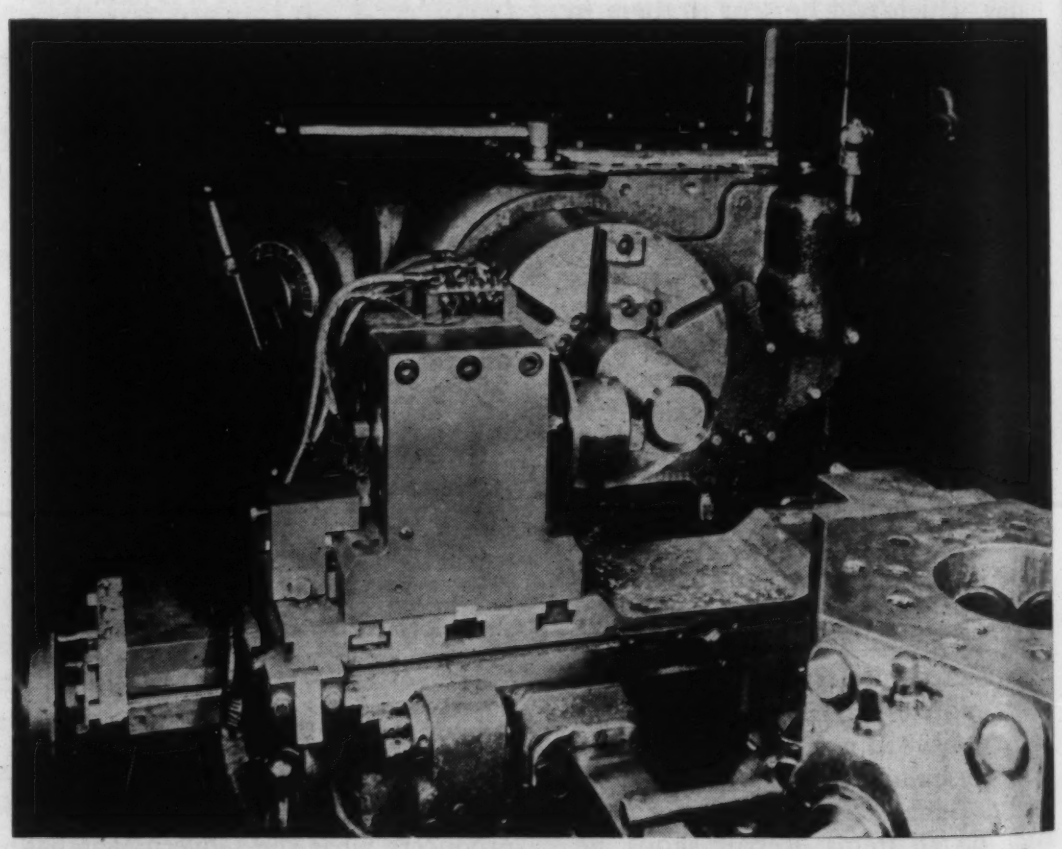
and pressed metal products; valves and fittings; anti-friction bearings; food products machinery; textile machinery; woodworking machinery; paper making machinery; printing and publishing machinery; special industrial machinery, such as rubber, plastics, chemical, foundry, tobacco, glass, cotton, clay, cement, concrete products, etc.; aircraft and aircraft parts; truck trailers; metal shipping containers; screw machine products; industrial furnaces and ovens; mechanical stokers; office machines; scales and balances; commercial laundry and dry cleaning machinery; sewing machines, except household; vacuum cleaners, except household; refrigeration and air conditioning equipment, except household refrigerators and freezers and comfort air conditioning; measuring and dispensing pumps and lubrication equipment; commercial service equipment, except household types; electrical wiring devices and supplies; carbon and graphite products; electrical indicating and measuring instruments; lighting fixtures.

Also, tacks, staples, cut nails and spikes; wire work products, such as wire cloth, wire chain and wire springs; safes and vaults; steel springs; bolts, nuts, rivets and other industrial fasteners; collapsible tubes; internal combustion engines; transformers; capacitors, rectifiers, induction and dielectric heating units; electrical accessory equipment for internal combustion engines; electric lamps, incandescent and fluorescent; radio, radar and television equipment, except home type; radio tubes; telephone and telegraph communication equipment; storage batteries; primary batteries, dry and wet; x-ray and therapeutic apparatus; motor vehicles, except passenger type; small arms; small arms ammunition; cooperage; millwork, such as door frames, windows, etc.; prefabricated wooden buildings; fruit and vegetable baskets; wooden boxes;

Also, lasts; wood products—ladders, tool handles, etc.; mattress and bed springs; wood office furniture; metal office furniture; furniture for schools, churches, etc.; professional furniture for laboratories, hospitals, but not beauty shop or barber shop; partitions, lockers and shelving; window and door screens; restaurant furniture; paperboard boxes; fiber cans, tubes and drums; periodicals; books; commercial printing; loose leaf binders; tires and inner tubes; rubber footwear; mechanical rubber goods; leather belting; shoe findings; luggage; saddlery and harness; flat glass products; concrete products (reinforced); abrasive products; insulation, packing and gaskets; cutlery; edge tools; hand tools; files and rasps; hand saws and blades; other hardware; plumbing fixtures; oil burners; heating and cooking equipment, except residential; metal doors and sash, frame, etc; sheet metal products, such as roofing, culverts, etc., except awnings and radiator enclosures; farm wagons, wheel barrows and hand carts; aircraft, scientific and surveying instruments; mechanical measuring and controlling instruments; opitcal instruments and goods; dental, surgical and medical instruments and appliances; photographic equipment; clocks and watches; pens and pencils; marking devices; buttons, needles, pins and fasteners; brooms and brushes; morticians' goods; fire fighting equipment; repair and replacement parts.

Products Not Under CMP

The tentative list of products for which applications are not required is as follows: Motor vehicles—passenger type; household refrigerators and freezers and comfort air conditioning; heating and cooking equipment—residential; household electrical appliances; vending and amusement machines; sewing machines—household; vacuum cleaners—household; home radio and television sets; automobile trailers (not including truck or house trailers); sheet metal awnings and radiator enclosures; venetian blinds; household furniture; professional furniture for beauty and barber shops; window shades; women's hand bags; small leather goods; household stamped and pressed metal products (including enameled); domestic laundry machinery; household service equipment, such as dishwashing machines, water softeners, polishing machines; motorcycles and bicycles; jewelry and jewelry findings, silver and plated ware; pianos, organs, musical instruments and parts; games and toys, children's vehicles; dolls; sporting and athletic goods; artist materials; costume jewelry; artificial flowers; lamp shades; barber and beauty shop equipment; signs and advertising displays; umbrellas and canes; cigarette holders and tobacco pipes; soda fountain and beer dispensing equipment.



Measurement of the loads on a lathe tool by SR-4 strain gages were among the problems solved by engineers of Jones & Lamson Machine Co. in preparation for a broad research program on carbide high-velocity turning. The work was reported by Leif Fersing, experimental engineer, at the annual meeting of the American Society of Mechanical Engineers.

Materials Discussed at Electrochemical Society Meeting

A number of papers of interest to materials engineers and designers were presented at the 99th meeting of the Electrochemical Society in Washington, D. C. on Apr. 8 to 12. Discussions were conducted in six groups, covering electric insulation, electronic and luminescence, rare metals, electrothermics, industrial electrolytic problems, and theoretical electrochemistry.

The sessions on electric insulation heard several papers on the manufacture, composition and insulating properties of glass-fiber paper in addition to three interesting discussions on the use and properties of plastic laminates in dielectric applications.

John M. Leonard, U. S. Naval Ordnance Plant, Indianapolis, in an evaluation of the effect of fungi on some of the new plastics, showed that in certain cases the problem has lost the seriousness it once had. The results of intensive research on fungicides has also lessened the danger to electronic equipment.

The preparation, production and fabrication of asbestos electric insulation was discussed by Jesse M. Weaver, of Raybestos - Manhattan. American sources of asbestos have not produced material up to the quality standards of imports, for reasons given by Mr. Weaver. He suggested a number of approaches toward improving the native product, and evaluated the insulating applications of asbestos and the refining methods used in Europe.

E. B. Fehr and A. P. Haase, of the General Electric Co., presented a paper on Terratex, a new material based on asbestos sheet, used for spacing and insulating metal parts in vacuum tubes. A comparison was made between Terratex as to cost, availability and ease of fabrication, and the differences between the mechanical properties of the two materials were explained. The new formulation has important advantages with respect to tube noise and microphonics, according to the authors, but is limited in its usefulness in other respects.

The Rare Metals group heard four particularly interesting papers on molybdenum, covering mechanical, physical and fabricating properties. E. S. Byron and R. F. Baker, of Westinghouse, covered the effects of working on the properties of molybdenum. Heat treated, unworked molybdenum made by powder metallurgy process has an ultimate strength of about 60,000 to 70,000 psi and an elongation of usually less than 1%. Upon rolling or forging at suitable temperatures, however, the strength increases and, under some conditions, the ductility is greatly improved in the direction of the metal flow brought about by the working. The hardness during working is increased more or less equally in all three axial directions, but there is little improvement in strength or ductility in the compressive direction, that is, the direction in which flow does not take place.

Investigations on the ductility of recrystallized wrought molybdenum were reviewed by W. E. Few and G. K. Manning, of Battelle Memorial Institute. It has been found that wrought molybdenum wires are extremely brittle when quenched from 3800 F, but ductile if cooled slowly. Reheating the quenched wires within the temperature range of 2000 to 3500 F also restores the ductility. The mechanism causing these differences is not fully understood, and studies are in progress which attempt to link the varying ductility with small changes in chemical composition.

A third paper, by B. Rightmire and John Wulff, discussed brittleness of recrystallized molybdenum. From tensile test studies on polycrystalline molybdenum annealed and tested in controlled atmospheres, it was found that single crystal molybdenum wire is stronger and more ductile than room-temperature fully-annealed polycrystalline wire. At 572 F both exhibit ductile fracture, but the polycrystalline material is stronger. Auxiliary studies using molybdenum of different purity and heat treatments in different atmospheres indicate that the above mechanical behavior may be attributed more readily to grain boundary precipitates than to texture.

Various mechanical properties of

(Continued on page 13)

Materials Control Orders
appears on page 7 of this issue

News Digest

Matter of Fact
BY EDWARD A. JOSEPH
A GIANT, 180-FOOT-HIGH GLITTERING
ALUMINUM SCREEN.
RESEMBLING A LARGE VENETIAN BLIND AND SUSPENDED FROM THE WALL OF THE FIRST NATIONAL BANK IN PHOENIX, WILL SOON SHADE THE TOP 12 FLOORS
OF THE 17-STORY BUILDING FROM BLISTERING SUN RAYS WITHOUT OBSTRUCTING OFFICE WORKER'S VIEW
THE BRITISH PATENT OFFICE CELEBRATED ITS 500th ANNIVERSARY AND HAS ISSUED ONLY 1,500,000 PATENTS SINCE ITS FOUNDING — WHILE THE UNITED STATES PATENT OFFICE, WHEN 160 YEARS OLD, HAS ISSUED MORE THAN
2,500,000
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News Digest

arc-cast and powder metallurgy molybdenum were covered by J. H. Bechtold and H. Scott in a discussion of their investigations. Having found that molybdenum can be so wrought and annealed as to have high ductility as fully recrystallized, an effort was made to make a comparison in this preferred condition of one lot of molybdenum as consolidated by powder metallurgy methods with another lot consolidated from powder by arc-casting. The results show very little difference between these products in either tensile properties determined over a range of temperatures above and below atmospheric or in creep strength at 1600 F. Particularly significant is the finding of a well-defined transition between ductile and brittle fracture on tensile test at a temperature only slightly below atmospheric which is similar to that occurring in iron at lower temperatures.

The fine-grained, fully recrystallized condition in pure molybdenum is unfavorable to creep strength as it is known to be in other pure metals, but its creep strength is remarkably high relative to other pure metals of lower melting point and even to alloys of the same.

New Technique Developed to Study Corrosion

Electrochemists at one of the country's largest industrial research centers have established another beachhead in their battle against the harmful effects of corrosion. A new technique, designed to measure the effects of corrosive solutions, may substantially reduce the nation's annual corrosion costs, estimated at $5.5 billion, or about $37 per person.

Developed at Armour Research Foundation of Illinois Institute of Technology, under the sponsorship of the National Advisory Committee for Aeronautics, the new method is similar to television scanning and can be used for detection, study, recording and analysis of corrosion phenomena.

Dr. Howard T. Francis, supervisor of electrochemistry at the Foundation, explained that scientists can now measure corrosion as it takes place, regardless of the metal involved.

(Continued on page 140)

What materials would you choose?

1. CHLORINE CELL COVER: Previous cement covers deteriorated rapidly, gave rise to contamination in vorce cell, with consequent increased current and maintenance costs. Now made of material that combines high strength with superior electrical and chemical resistance to give longer life, cleaner product. What material?

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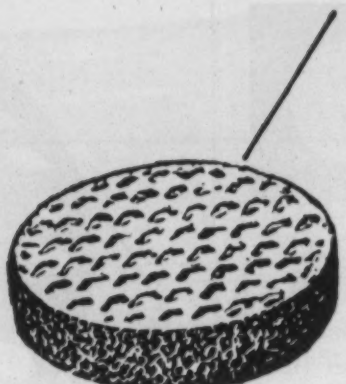
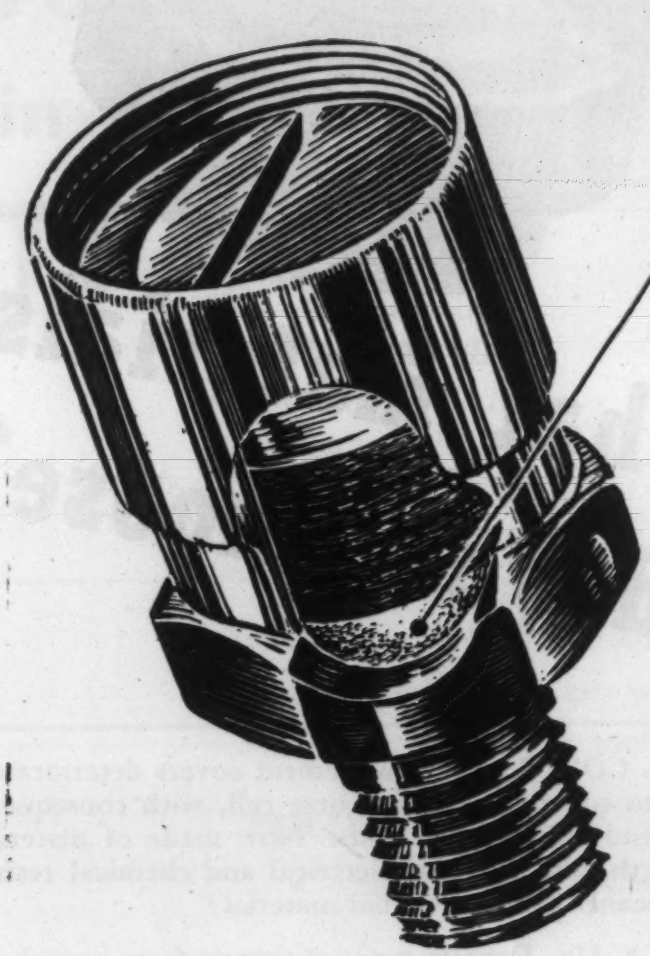


DAMS WATER ...VENTS AIR

in Ventmaster automatic valve for hot water heating systems



Ventmaster automatic air vent
by
The Keeney Manufacturing Co.,
Newington, Connecticut.

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Engineering Materials in Ordnance Equipment

Materials engineering is playing an all important role in the present build-up of our defense strength. Col. Mesick reviews the major applications of engineering materials in our military equipment, and discusses some of the current problems now facing the Ordnance Corps.

by **COL. BENJAMIN S. MESICK**, Chief, Research and Materials Branch, Ordnance Corps

• IT HAS BEEN ESTIMATED that at least 10,000 different types, classes and grades of materials are required in ordnance production and maintenance. This should give some idea of the scope of Ordnance interests and problems in the field of materials engineering.

It is the policy of the Ordnance Corps to use standard commercial materials wherever practicable and to develop and prescribe special materials only where necessary to obtain essential military characteristics and to assure reliable performance under the wide range of service conditions. However, it must be borne in mind that the need for assurance of adequate performance under all probable service conditions makes it necessary to impose on materials for some ordnance applications more severe requirements than those generally specified for similar civilian equipment.

We view the broad program of research and development of materials for use in ordnance as consisting of two parts. The first, and by far the larger, is supported and conducted by American industry in its constant endeavor to provide new and improved materials for civilian use in motor vehicles, farm machinery, aircraft, radios, refrigerators, and hundreds of other items. The second part consists of our specific Ordnance research and development program to provide materials which at present have no commercial counterpart; and to encourage and promote the speedy development of those new and better materials which will lead to improved ordnance equipment. To the extent practicable with our available materials engineers, we keep abreast of industrial development and standardization of materials, procedures and test methods.

It is obviously impossible to discuss here in detail all the materials of importance to the Ordnance program. Therefore, the best that can be done in the following paragraphs is to review broadly the applications of the major engineering materials in military equipment.

Steel and Iron

Steel is the predominant material of ordnance construction. The types, classes, grades and combinations of physical properties are too numerous even to mention here. Armor for tanks and other combat vehicles requires combinations of physical properties, not required normally for constructional applications, to provide the maximum ballistic protection for the weight used. The three major factors are soundness, hardness and toughness. As a result of many years of research, development and testing, including the experience gained during World War II, we have established definite correlation between these properties and ballistic performance against conventional armor piercing ammunition. This makes it possible to use tests which can be made in the laboratory for quality control and acceptance of armor. It is expected that the tremendous burden, expense and delays associated with ballistic testing during World War II can be greatly reduced if not eliminated in current and future production.

To obtain the necessary soundness and high hardness with adequate toughness, as determined by low temperature Charpy impact test, presents no serious or unusual technical problems to steel producers, fabricators and foundries accustomed to supplying high quality heat treated steel plate or castings, except where thickness and mass are considerably greater than found in quenched and tempered parts for commercial use. However, steel mills and foundries working in close cooperation with Watertown Arsenal have been able to obtain combinations of hardness and toughness in sections 6 in. and over in thickness, which a few years ago would have been considered impracticable if not impossible.

During World War II steel armor was welded with austenitic electrodes containing approximately 8 nickel and 18% chromium. Since then, Watertown Arsenal has continued the research started during the war by NDRC to provide ferritic electrodes suitable for welding armor and high-strength constructional steels. This research and the developmental work of industry has resulted in the availability of ferritic electrodes and much of the technical information necessary to produce strong tough welds in armor. We look to industry for the application of these to production welding on armored vehicles which will be necessary to conserve chromium and nickel; and for the development and application of automatic welding processes utilizing ferritic electrodes, which is very desirable.

Other ferrous metals, including malleable and pearlitic malleable iron, are used in ordnance. We expect that the newer nodular graphitic (or ductile) cast iron also will find many applications. It already has found some uses in ammunition.

Heat and Erosion Resistant Materials

Heat and erosion resistant materials are becoming increasingly important to our success in providing new and improved weapons. To withstand higher velocities or increased rates of fire, guns (both large and small) must be lined with materials which not only retain strength at elevated temperature but will not be eroded or worn away at a rapid rate by hot gasses and mechanical action of the projectiles. Some components of guided missiles also present complex materials problems. The practical solution of these problems is made more difficult because thus far the most promising materials for such applications contain very high percentages of critical alloys and, therefore, it is apparent that the development and evaluation of alternate materials must be undertaken.

Before real progress can be made in this field, better laboratory methods of evaluation must be developed to provide a means of rapidly screening prospective materials. The use of porcelain-coated mild steel to replace stainless steel in manifolds and mufflers of combat vehicle engines is being investigated as one means of conserving critical alloys.

Nonferrous Metals

Although the tonnage of nonferrous metals used in ordnance is small when compared with steel, these materials play a vital part, particularly in artillery fire control instruments and ammunition as well as in the conventional applications in motorized and mobile equipment.

Copper Alloys—Traditionally cartridge brass (70 copper, 30% zinc) has been used in larger quantities than all other nonferrous metals. Cartridge cases ranging from Caliber .30 to 120 mm are required by the million. The diminishing supply of copper and zinc and technical problems arising in connection with weapons of new design make it necessary to turn more and more to steel for cartridge cases, which involves numerous problems that cannot be dealt with in a brief general discussion.

Aluminum—Aluminum alloys, because of their potential criticalness during a large military production program, generally are used in ordnance equipment only where they provide a great advantage over less critical materials. During World War II Ordnance was allowed very little wrought aluminum alloy products since these must be made from primary metal and carefully segregated scrap. However, we were permitted to use considerable quantities of castings made from alloy ingots which the smelters were able to produce within reasonable composition limits from miscellaneous mixed aluminum scrap. The outstanding result of cooperation among the smelters, the die casting

A variety of engineering materials selected to meet severe end service requirements are used in the modern tank. (Courtesy U. S. Army)

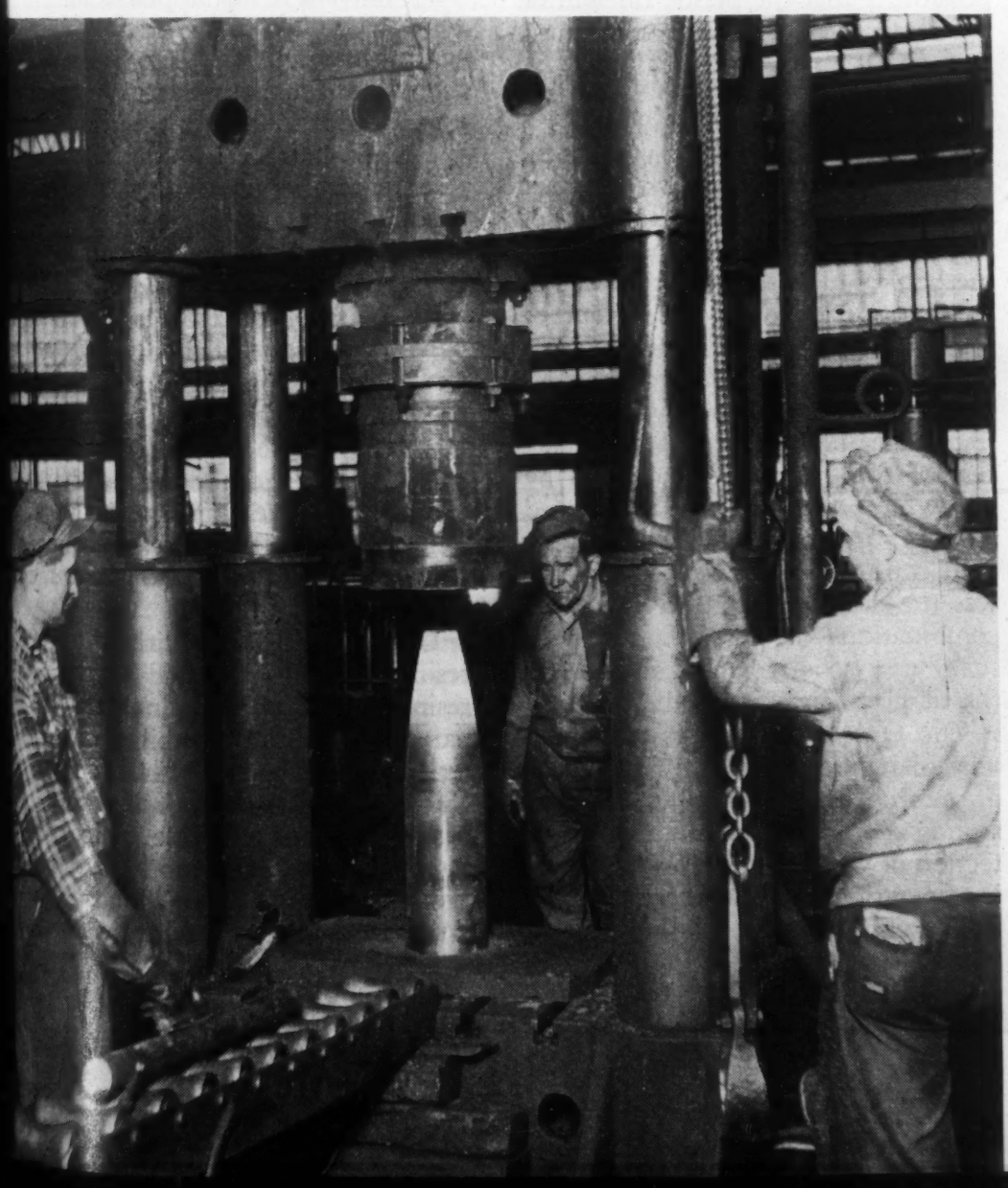
industry and the Ordnance Corps was Specification AXS-679, under which were procured millions of die cast parts, mostly ammunition components. The series of die-casting alloys covered by this specification, and its successors, which require no primary aluminum, has found wide use in industry and undoubtedly will continue to be used in ordnance.

Standard commercial alloys are used for practically all of the limited number of ordnance applications for which wrought aluminum is considered to be essential. Ordnance supported research aimed at the improvement of physical properties of high strength alloys in thick sections (1½ in. and over) for special applications has produced some beneficial results which are expected to be reflected in commercial products.

Magnesium—The constant demand for improvement in performance with reduction in weight in all classes of ordnance equipment has led us to consider all kinds of constructional materials which provide a high strength-density ratio. Although much can be accomplished through the use of high strength steels, there are many applications where further savings cannot be made through reduction of section thickness and, therefore, we must look to some material of lower density. Because of the natural limitation on availability of aluminum, we turn to magnesium, which can be produced in larger quantity. Several factors have retarded the wide use of magnesium alloys in ordnance design. While lack of definite knowledge of the possibilities and limitations of these materials and limited experience in their fabrication undoubtedly have been the chief deterrents, poor resistance to abrasion, heat and corrosion also have been real obstacles.

However, the practically unlimited availability of raw material, particularly magnesium salts in sea water, and the steady progress in development of alloys with better physical properties, such as has resulted from Army supported research by Dow Chemical Co. during the past four years, has caused the Ordnance Corps to continue the search for solutions to the various technical problems. We have had very encouraging results from research at Frankford Arsenal to provide a protective surface treatment. A new process has been developed for producing electrolytically a hard, adherent, refractory ceramic coating, which promises to provide protection against corrosion far beyond anything now in use commercially, together with excellent resistance to abrasion and ability to withstand heat. This will open the way to wider use of magnesium alloys in ordnance and industry.

Forging the nose on a large caliber projectile.



Titanium—Titanium and titanium alloys should not be omitted from any current discussion of constructional materials of high strength-density ratio. Although these materials are not used in any ordnance item currently scheduled for production, the availability of titanium ore, the exceptional strength of the alloys at normal temperatures, plus unmatched corrosion resistance make it appear certain that they will be used in many ordnance items where it is important to reduce weight and improve performance. It is conceivable that titanium alloys can be substituted thickness for thickness for steel armor, reducing armor weight by about 40%. Similar weight savings in some structural components of military vehicles also are anticipated. So much has been written recently on this subject that it is considered unnecessary to devote further time to detailed discussion here.

Rubber

As often stated, the mechanized Army of today literally rides into battle on rubber, with the predominant use being in combat and transport vehicles. Successful use of rubber in military tanks, trucks and other vehicles requires the same properties in the material and the availability of the same engineering data which you find necessary for automotive applications. In addition, special characteristics must be obtained in some materials and more engineering data must be provided to meet the more severe conditions of military service. Some of these conditions are suitability at extreme temperatures, resistance to unusual fuels and lubricants, maintenance of original properties after lengthy periods of exposure, and sufficiently high strength properties to permit operations on rough terrain found in battle areas.

In addition to meeting the specified military requirements, there is the ever present problem of conserving our natural rubber stockpile to assist in gaining independence of foreign sources of supply. This becomes exceedingly difficult when it is recognized that we must not only maintain minimum properties in the material but seek constant improvement. The largest consumption of natural rubber is in large-size tires where an adequate replacement material has not been found. The Office of Rubber Reserve, in cooperation with the Ordnance Corp and industry, is actively prosecuting this problem, and an early and

successful conclusion is hoped for.

One of the most difficult rubber problems in motorized equipment which the Ordnance Corps has been called upon to meet is the joint requirements of flexibility at low temperatures and resistance to oils and fuels. The butadiene acrylonitrile rubbers with low acrylonitrile content compounded with plasticizers of as low an extractability as possible are the best rubbers for this purpose currently available. However, research is being conducted to develop improved materials, and several offer promise.

In non-oil resistant applications, many rubber plastic combinations, modified rubbers and low styrene butadiene rubbers offer advantages and improvements relative to specific properties, such as oxygen and ozone resistance, increased abrasion resistance and tear strength, and better low-temperature brittleness.

Plastics

Plastics are of interest to ordnance for several reasons. Since, generally, they can be synthesized from organic sources, placing little or no demand on our mineral resources, availability of plastics is governed mainly by production facilities rather than inflexible natural limitations. For this reason, from a long range viewpoint, plastics can be considered more expendable than most other classes of engineering materials. Consequently, for applications where the material in the item cannot be recovered, the use of plastics in lieu of metals represents conservation of natural resources. It is possible with plastics to synthesize materials with a wide variety of physical as well as chemical properties. In addition, fabrication techniques have been and are being developed which permit much more flexibility of design than is obtainable with other materials.

The general public, unfortunately, frequently is made aware of the shortcomings of plastics due to the many misapplications in which they have been involved. It is the aim of the Research and Materials Branch of the Ordnance Research and Development Div. to avoid improper usage like the plague. Those who have worked with plastics, on the other hand, are well aware of what they can do and are convinced that they should at least be considered in the development of every new item of ordnance. Frequently, the requirements for the item obviate the need for further discussion. For some uses, plastics simply will not work. On the other hand, the advances which have been made during the last year or two are unfamiliar not only to the public but to very many design engineers. There are plastics today with tensile strength of the order of 100,000 psi, impact resistance of 25 ft-lb, and flexural strength of 32,000 psi. These figures compare favorably with properties of metals. There are also several plastics which will withstand the extremely low temperatures which we may encounter in the event that we have to fight a war in the Arctic.

Already, plastics have proven themselves in such industrial applications as fuel lines, water storage tanks, electrical housings, and wire insulation. It has been rather well established that the plastic-glass-fiber boat is here to stay. Plastics have proven satisfactory in the aircraft industry for many structural parts, for fuel lines, for windshields, and even in propellers. Ask the fisherman about the plastic-glass combination fishing rod.

The successful functioning of plastics in a number of these tough applications give assurance that at least from the standpoint of performance, plastics are worth considering. It is well recognized that many of the best materials for these uses are not yet in sufficient supply for general utilization, and also that mass-production techniques have yet to be perfected. It is, however, within the realm of possibility that the plastic car will be produced in the not too distant future.

Adhesives

Up until fairly recent years most structures were joined together through the use of nails, screws, welding, soldering, rivets, and various mechanical means, such as threaded or friction joints. With the advent of synthetic resins, there began an intensive study to develop adhesives. Initially, most of this work was concentrated on adhesives for wood. The success of this program was shown by the widespread use of large glued wooden parts for shipbuilding and aircraft construction. A further outcome was the development of a variety of combinations of different materials, such as wood-metal, metal-plastic, plastic-glass, and many others.

The Ordnance Corps is concerned with many problems involving the use of marine grade adhesives, such as sealing and luting compounds for protection of vehicles in deep water fording operations and for securing watertight joints in general in automotive equipment. To these can be added the special problems of sealing artillery fire control instruments and joining components of ammunition. It is necessary that adhesives for most of these applications be capable of withstanding extremes of temperature and other severe conditions to which military equipment is exposed.

Organic Coatings

Protective coatings have advanced rapidly in the past ten years. The materials shortages of World War II made it necessary for us to use many raw materials which had not been used before. While we were able to meet the minimum requirements and obtain indications of the possibilities of new formulations, the necessity for frequent changes and other urgent problems made it impracticable to do research and development necessary to obtain the best protection with the available materials. After the war steps were taken to more thoroughly evaluate the newer materials and formulas and to find solutions for some of the difficulties that had been encountered.

The desirability of using fast air-drying organic coatings has been recognized for a long time. Lacquers appear to provide a logical solution, but in the past they have been considered inferior to enamels where severe service is anticipated. Also, it is very difficult, it not impracticable, to obtain a satisfactory lustreless finish with lacquers. After gloss finish was authorized for use under some conditions, Ordnance, in cooperation with the paint industry, developed a lacquer refinishing system consisting of a sanding surfacer and a full-gloss top coat. Specifications for these materials have been issued. Approximately three years of outdoor exposure of panels indicates that this lacquer system closely approaches the alkyd enamels in durability, gloss and color retention. At the present time, research is being conducted on the so called "hot lacquer", and specifications requirements are being determined for these materials for automotive and ammunition finishes.

One of the latest additions to the resin field is the styrenated alkyd. This resin has very fast drying and, apparently, excellent durability characteristics. It has one drawback for general ordnance applications in that it has poor solvent resistance. This characteristic is not objectionable, however, in coatings used for ammunition. Enamels based on this resin have been

developed for such use, and data obtained so far indicate that they are far superior to those used for the same purpose during the past war. Indications are that, insofar as the resin may be available, it will be used in large quantities for ammunition and, possibly, other applications in the future.

Testing time has always been a drawback in the procurement of protective coatings. Much research has been devoted to methods of test that will reduce the time necessary between manufacture and acceptance or rejection of the coating materials. The following will serve as examples of the progress attained by the Ordnance Corps in shortening the testing time:

A specification for a wood sealer specified a two-weeks test for fungicidal activity. Research produced methods of tests for fungicides not previously available. Now methods of chemical analysis are available for pentachlorophenol, salicylanalide, and phenyl mercuric oleate, cutting the testing time from two weeks to approximately one day. Another problem arose because of the lack of reliable test methods. Certain paint manufacturers were substituting zinc chromate and white lead for the specified pigments, red lead, lead chromate and zinc oxide. This practice was stopped by the development of specific test methods for red lead and lead chromate in this particular pigment combination. Of particular interest to the paint industry was the development of specific methods of analysis of phthalic anhydride and other dibasic acids. Formerly, the accuracy of analysis was in the neighborhood of ±2%. The new methods have reduced this error to a maximum of ±0.5%.

Some painter's unions have objected to the spraying of paints and enamels containing lead. To overcome this obstacle the Ordnance Corps has undertaken an extensive research project to obtain a lead-free primer that will give the required protection against corrosion. Approximately 100 different formulations have been made, tested in the laboratory, and are now on exposure at Aberdeen Proving Grounds, Panama, White Sands, and Churchill, Canada. These panels have been on exposure for over two years and, while some failures of primers are evident and indicate a trend, the test has not progressed far enough to evaluate the results and recommend the best formulations.

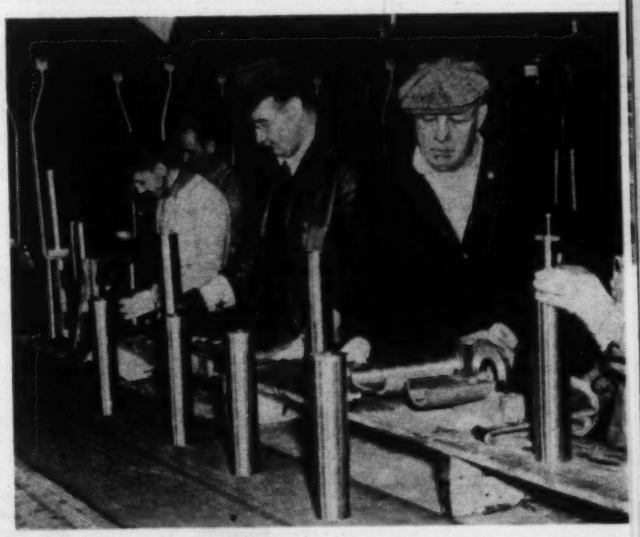
Perhaps one of the most disappointing coatings of the past war was the lustreless olive drab enamel. It lacked two of the most important characteristics—durability and color retention. Since camouflage enamel is so important, we have formulated nearly 100 different lustreless olive drab enamels in an effort to provide a better material for nonfading, durability and abrasion resistance. Panels bearing these enamels are currently on exposure at Sierra Ordnance Depot; a location chosen for its climate, extremes of temperature, and sand storms. It is believed another year of exposure will give the answer.

It being generally agreed that the paint finish is no better than the surface to which it is applied, Ordnance has not neglected this phase of the problem. A superior phosphoric acid metal conditioner has been developed and is currently being procured. A new type of test to determine the quality of heavy phosphate coatings has been developed to replace unreliable salt spray test. This new test was developed just recently and has not been specified up to this time.

Along with research on protective coatings, cleaning compounds of various types are being investigated. To date, a self emulsifying grease cleaning compound has been developed that appears to be far superior to material currently being procured. An effective alkaline cleaner and paint stripper of low pH (under 12.5) has also been developed.

This discussion provides indications of the scope of ordnance interests and problems in the field of materials engineering. From experience during and since the last war, we are convinced that to the extent practicable, we should equip ourselves to make effective use of all available materials in order to promote the development of new and better Ordnance equipment and practice true conservation of materials in event of any emergency. The word "we" does not include only Ordnance personnel or all Government agencies, but applies to materials engineers, metallurgists, chemists and others throughout Government and industry.

This article is based on a paper presented at the Society of Automotive Engineers National Passenger Car, Body and Materials meeting in Detroit, Mar. 6-8, 1951.



Steel is again being adopted for cartridge cases to replace scarce copper alloys.

Amphibious 2½ ton trucks, commonly known as Ducks, at a storage depot awaiting overseas shipment. (Courtesy Signal Corps)

Carbonitriding Produces Hard Case at Lower Temperatures

by **SAMUEL DAMON,**

Materials Engineering Dept., Westinghouse Electric Corp.

Where large quantities of small parts can be treated simultaneously, dry cyaniding has advantages of lower cost, less distortion, and cleaner, safer operation.

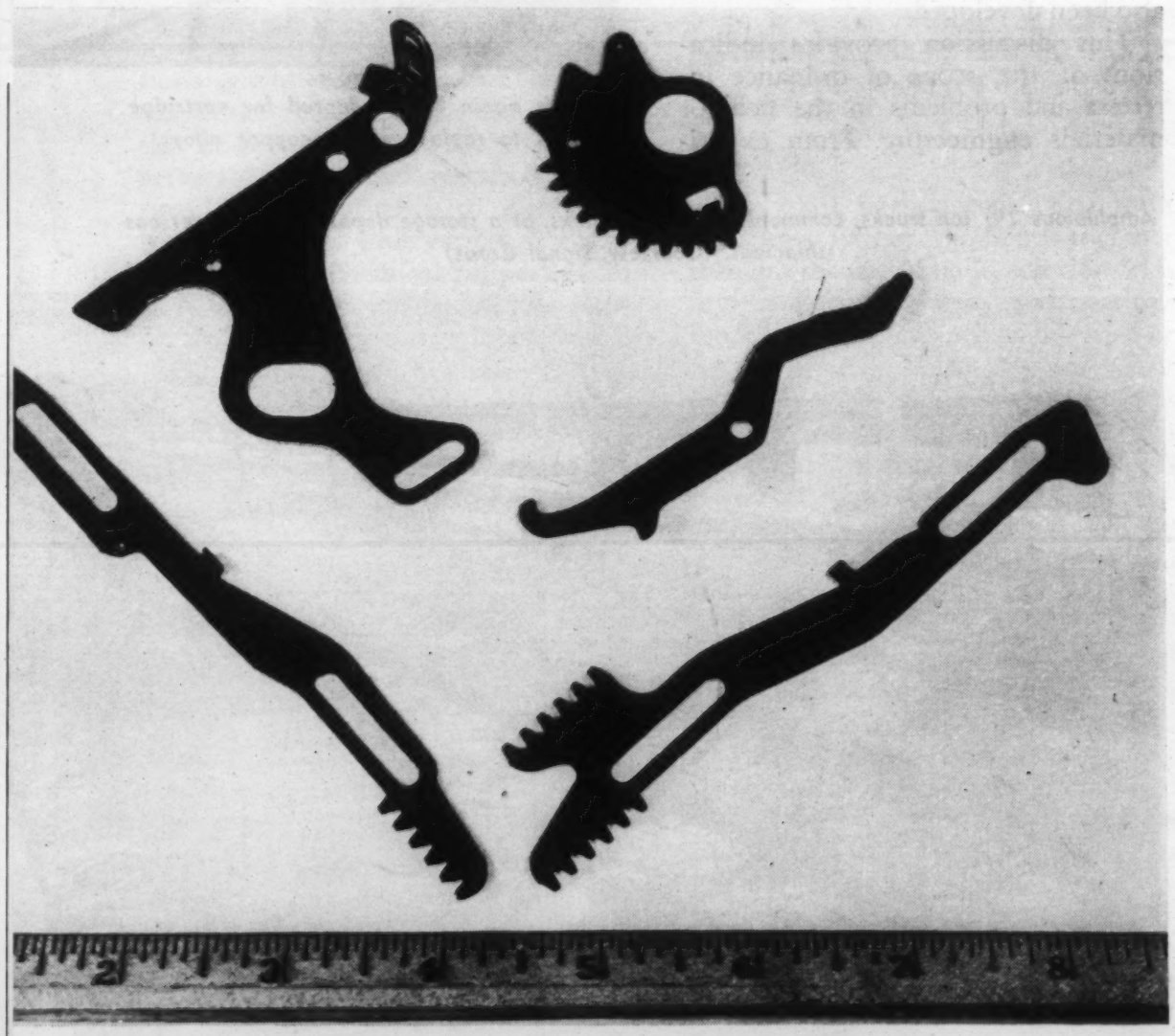
• IN THE TREATMENT OF steels to produce file-hard surfaces it has been found possible to improve the hardness of the case greatly, as well as to reduce the temperature at which the case is formed, by the introduction of ammonia along with the carburizing medium. This manner of case production is very similar to liquid cyaniding in the type of case formed, and therefore, it is sometimes spoken of as dry cyaniding. In the presence of nascent nitrogen supplied by the ammonia, carbon is absorbed into the steel at temperatures well below the ordinary carburizing range. Thus, in the region of 1110 to 1560 F, a surface high in carbon and nitrogen can be produced which can be hardened by atmosphere cooling or oil quenching.

The type of case produced, *i.e.*, hardness, depth, carbon-nitrogen content, and other characteristics, is determined largely by the temperature, the time, and the ratio of ammonia to carburizing constituents in the gas. These variables are set after the type of case desired has been determined.

The series of photomicrographs shows how the type of case is altered as the temperature and time of treatment change. As would be expected, the depth increases with temperature and time; however, in addition, the type of case formed varies as the temperature is changed. The case formed at temperatures up to 1290 F shows a characteristic white layer and only a small amount of martensitic constituents below this point. As the temperature is increased above 1290 F, the case assumes more and more the appearance of a carburized surface. However, the nitrogen content of this case is higher than would be found in any ordinary carburized case.

For processing the parts a gas-tight furnace is employed. It is equipped to insure adequate and uniform distribution of the gases throughout the charge, usually by fan circulation. A cooling chamber, as well as quenching tanks, are used to give flexibility in cooling rates. An atmosphere such as is delivered by an Endogas generator is fed to the furnace, and through another inlet are introduced metered quantities of ammonia and a carburiz-

A number of adding machine parts that were carbonitrided.



ing gas such as methane. The treatment is completed by cooling in the same atmosphere or by oil quenching.

Advantages of Method

The benefits of this type of treatment include extremely high wear resistance, high case hardness following relatively low treating temperatures, and less drastic quenching requirements. In addition, plain steel can be substituted in many cases for alloy steels where core properties are not too important. Some evidence exists which indicates that increased resistance to corrosion results from this treatment. Among other advantages of this method is its lower cost, especially on small parts where large quantities can be treated simultaneously. Distortion during processing is much reduced. Finally, the operation of carbonitriding equipment is much cleaner and safer than for liquid cyaniding equipment.

The accompanying figure shows a variety of adding machine parts following carbonitriding treatment. Other parts today being treated by this method include ball bearing races, separators and spacers, gears, chain links, typewriter parts, set screws, and many other types of parts subjected to wear.

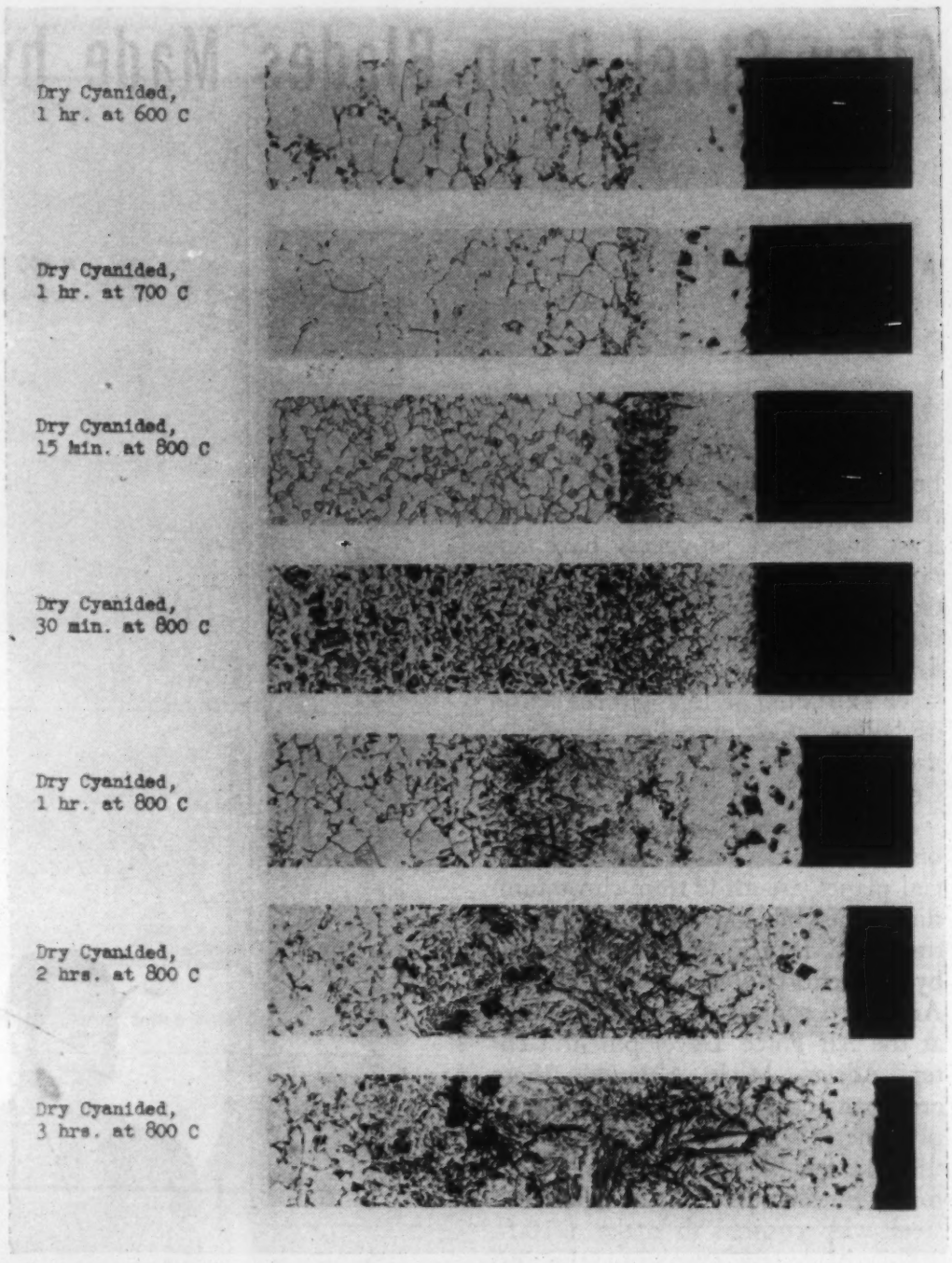
Typical Application

An example of the application of carbonitriding will give an indication of its usefulness. In an investigation into many materials for use as liners in the compacting of silicon carbide lightning arresters, the most satisfactory from a cost per compact standpoint was found to be cold-drawn low-carbon steel tubing which had been carbonitrided.

The tubing is cold drawn to final dimensions running from 2- to 4-in. I.D. and cut off in 5-in. lengths to form the liners. Each batch of liners is treated 4 hr at 1650 F, furnace cooled to 1290 F, held for 1 hr, and oil quenched. This is followed by tempering at 390 F for 2 hr. Because of the low quenching temperature used, adequate hardening is obtained without an objectionable amount of distortion.

The resulting liners are found to last long enough, and to be so low in cost, that it is more economical to use a new liner when dimensional limits are exceeded through wear than to grind and reharden the core, as was the former practice.

The accompanying table shows how the various methods compared on a tool cost per compact basis. The method formerly employed is listed first. Following the machining and heat treating operations, the cost per piece was 3 1/3c . For the second, manufactured from high-carbon high-chromium tool steel, the cost was 3 2/3c. Using a cemented carbide liner, the cost rose to 9 1/2c. By the carbonitriding technique, the tool cost was lowered to less than 1c per compact.



These photomicrographs show how the temperature and time of treatment affects the type of case produced.

Comparative Cost Per Compact for Various Liner Materials

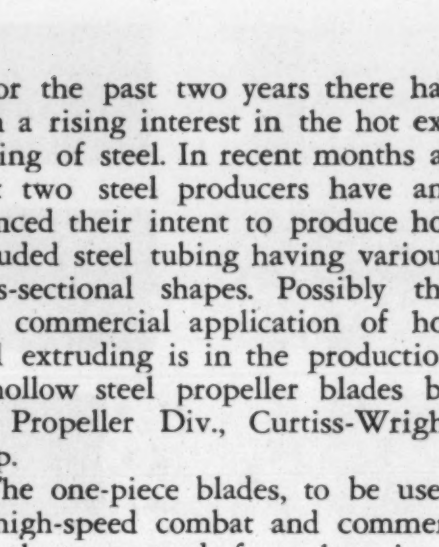
Material	Machining	Heat Treatment	Finishing	Cost per Piece Molded
Shelby Tubing	Cut off and chamfer	Pack carburize, harden and temper	Grind bore	$ .033
#15 Tool Steel	Cast, anneal, machine and grind	Harden and temper	Grind bore	.036
Cemented Tungsten Carbide			Grind bore	.095
Shelby Tubing	Cut off and chamfer	Dry cyanide and temper		< .010

Alloy Steel Prop Blades Made by Hot Extruding

A PICTORIAL STORY

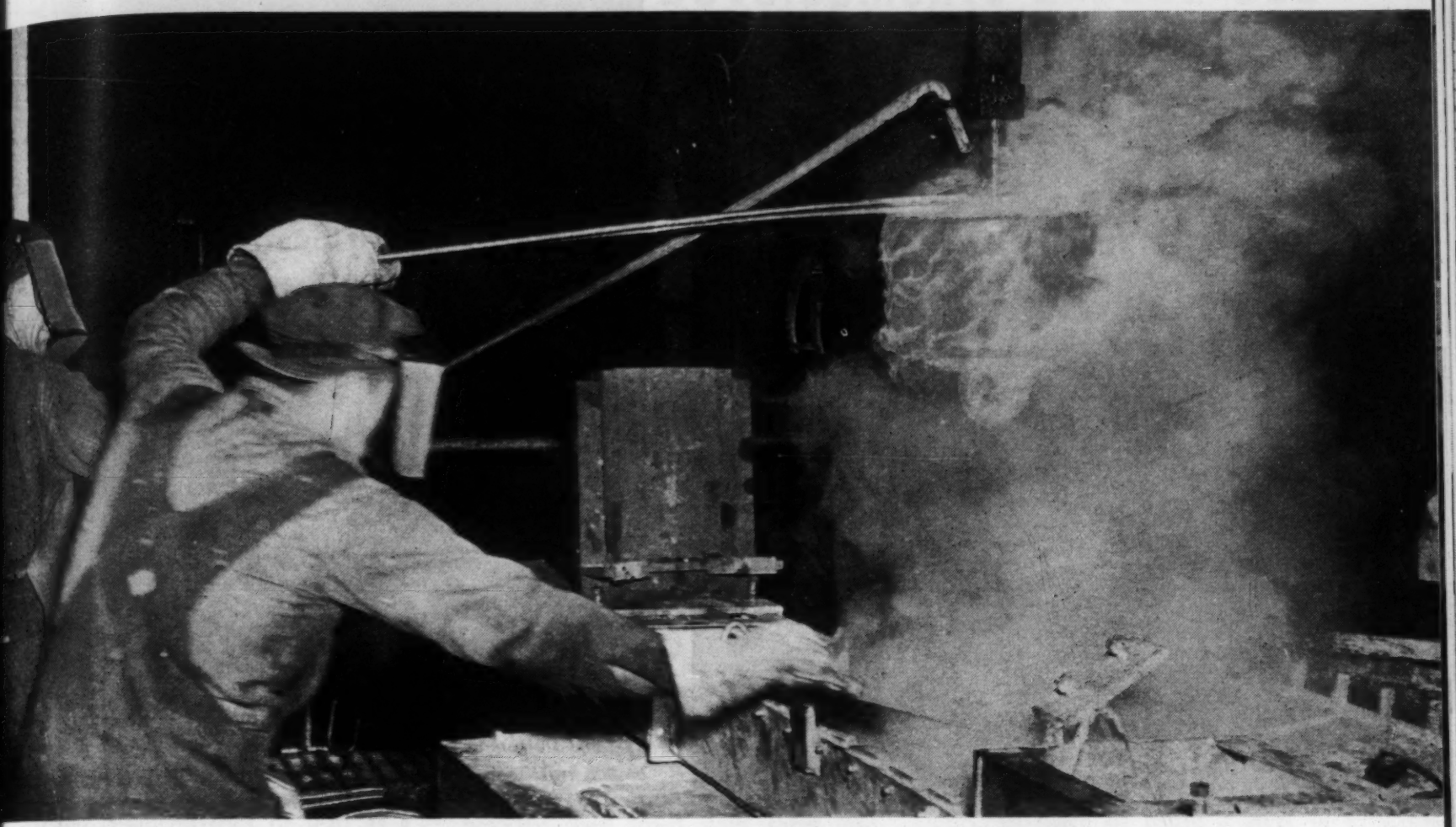
For the past two years there has been a rising interest in the hot extruding of steel. In recent months at least two steel producers have announced their intent to produce hot extruded steel tubing having various cross-sectional shapes. Possibly the first commercial application of hot steel extruding is in the production of hollow steel propeller blades by the Propeller Div., Curtiss-Wright Corp.

The one-piece blades, to be used on high-speed combat and commercial planes, are made from chromium-nickel-molybdenum steel in a 5500-ton press. Techniques were perfected by joint efforts of Curtiss-Wright and Air Force engineers. Work was done at the Air Force Development Center, Adrian, Mich. Although there are many advantages in producing propeller blades as extrusions, one of the greatest is the saving in material. By former methods, 750 lb of steel was required to make a 10-ft, 200-lb blade. By extruding, the initial requirement has been reduced to 400 lb. In addition, considerable savings are realized in machining time required to attain the final shape.

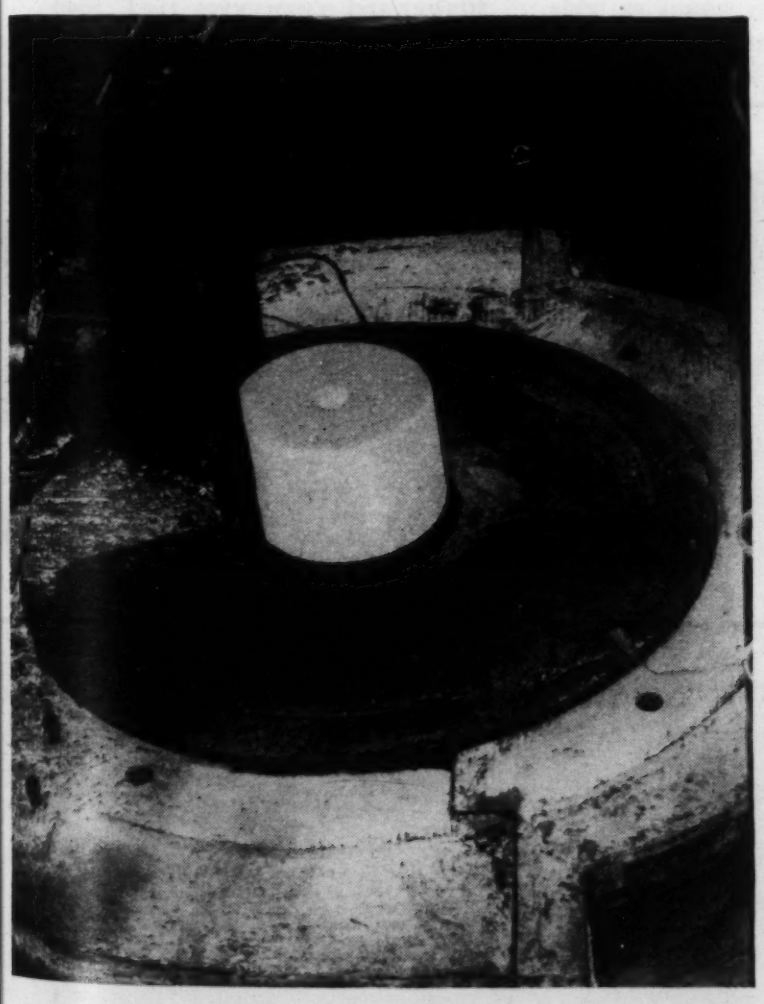


A 400-lb billet in this photograph is extruded to form a hollow-tube (center) which, after flattening and twisting, becomes a finished blade (right).

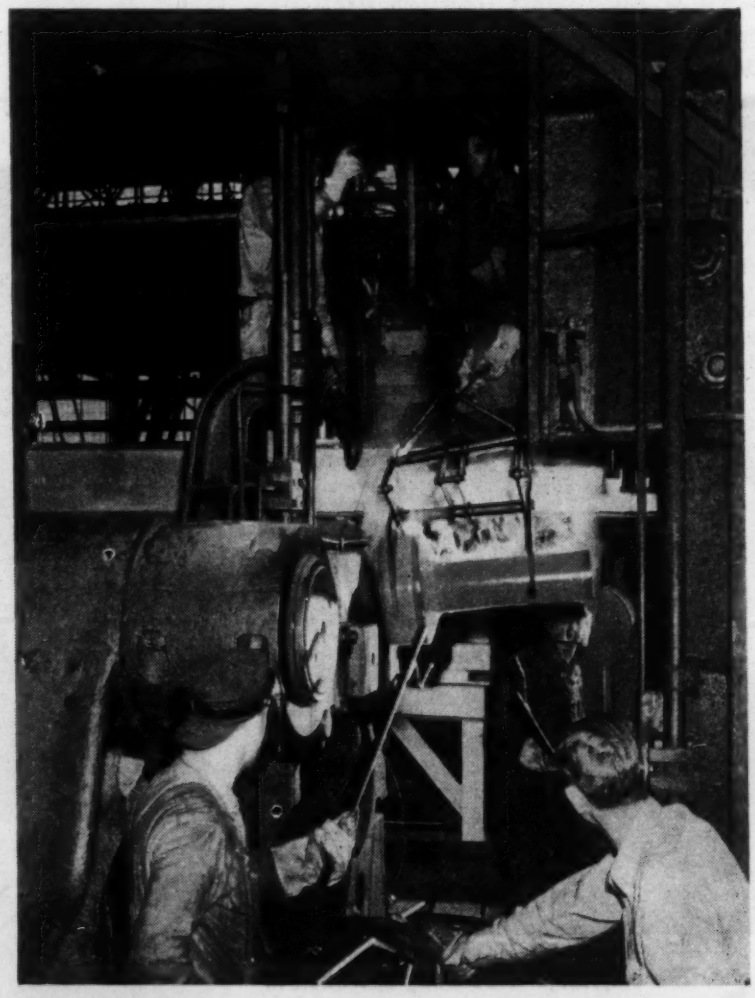
Here are step-by-step illustrations showing how an extruded blade is produced.



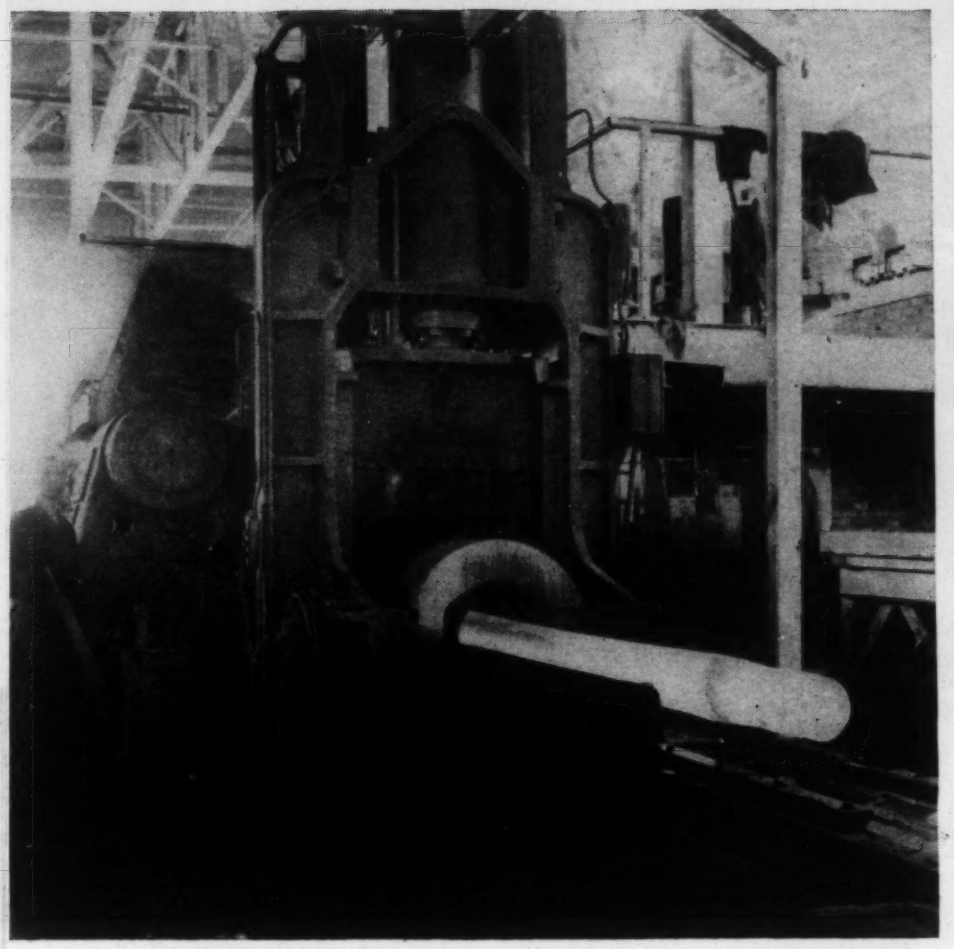
1 *The 400-lb chromium-nickel-molybdenum steel billet is taken from a salt bath furnace after heating to extruding temperature.*



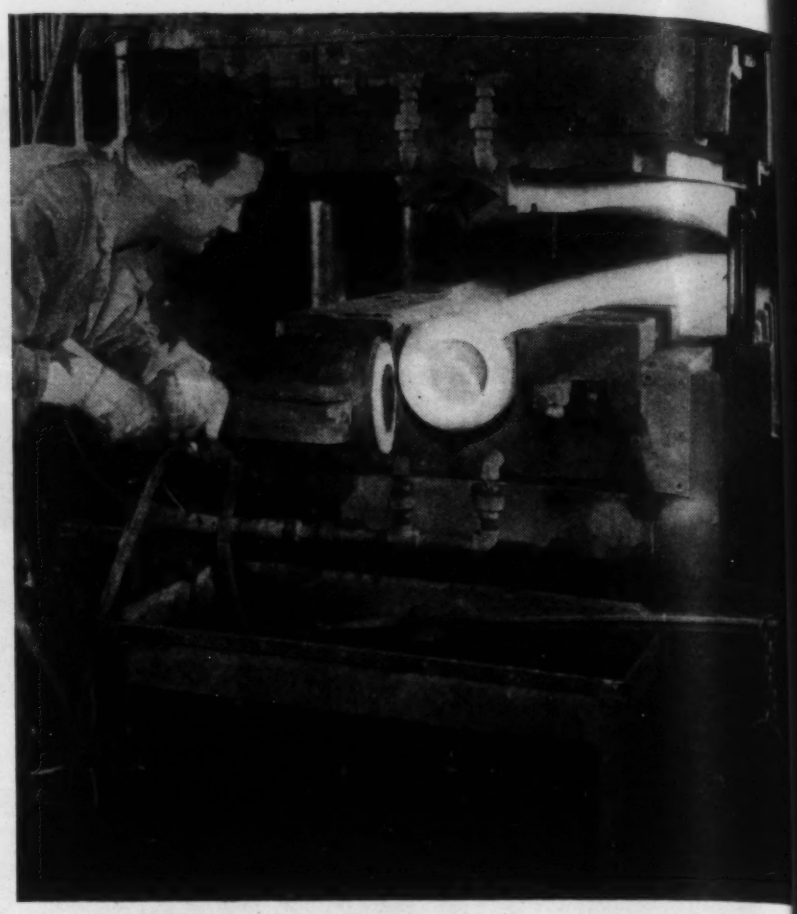
2 *The white-hot billet is then inserted in the die container of the extrusion press for the first forming operation.*



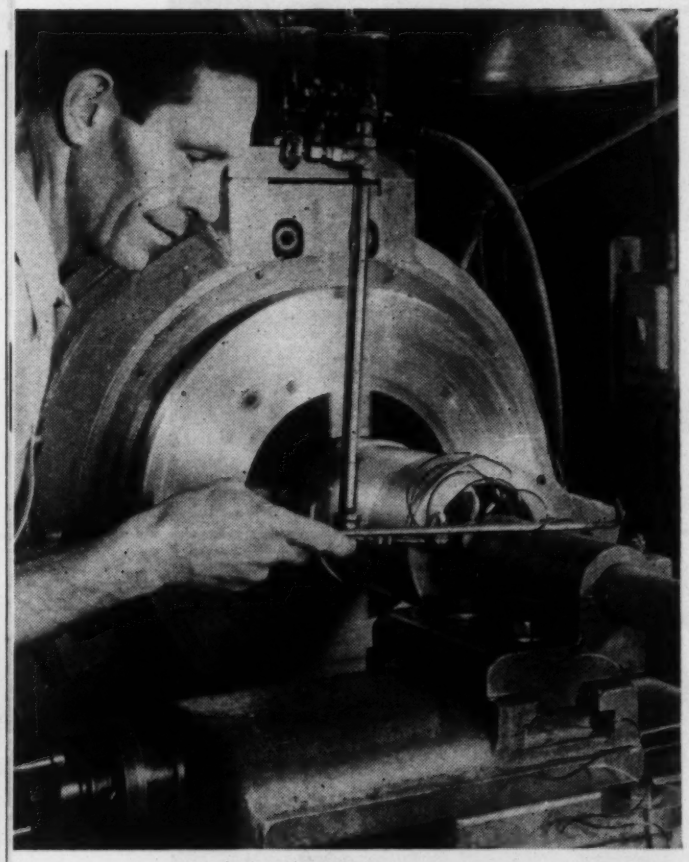
3 *After reheating, the first extruded shape is returned to the press for the second operation, where expanding and tapering is done.*



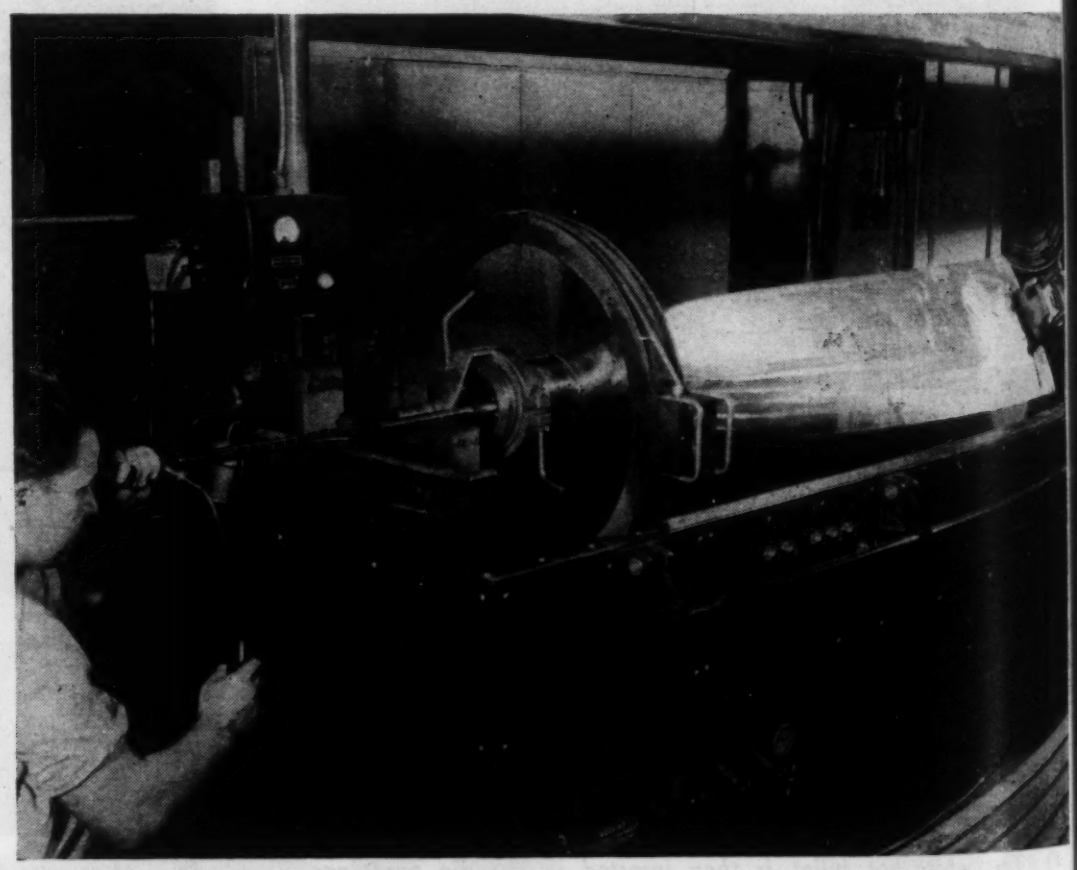
4 *Here the shank end of a blade emerges from the third extruding step. This completes the forming as done by extruding methods.*



5 *The extruded shape is transformed into a blade by again heating and flattening and then forming against a die which provides the proper twist and shape. Nitrogen, under 1100-psi pressure, provides internal support during this operation.*



6 *The only major machining operation in making a propeller blade by extruding is the machining of the shank end which fits into the propeller hub.*



7 *Completed blades are carefully and completely checked by Magnaflux inspection after final flattening and forming.*

New Developments Expand Use of Lead Construction

Improvements in lead fabrication and installation methods continue to keep pace with developments in the chemical and process industries.

by **KEMPTON H. ROLL**, Lead Industries Association

• LEAD HAS BEEN an important material for handling corrosive chemicals ever since the beginning of the chemical and process industries. Although other materials have been developed to compete with lead in this field the use of lead for corrosive handling has continued to expand. This is partly due to the inherent desirable characteristics of lead as a corrosion resistant material. But it is also due to the experience gained from long and varied use of lead in this field. This experience has taught where and how lead may be used to best advantage and has led to improvements in construction and installation methods which have kept pace with developments in the chemical and process industries.

Lead pipe for conducting corrosives, lead heating or cooling coils, sheet lead for tank linings, bonded lead linings, and various cast lead objects all figure among the customary uses of this metal. Acid and chemical manufacture, pickling, plating, anodizing, waste recovery, air pollution control, and a host of other operations are making use of lead's resistance to attack by corrosives—particularly sulfuric acid.

A review of modern lead construction methods will disclose the latest techniques and improvements, all of which have passed the test of actual industrial application. These include improvements in methods of supporting sheet lead; new methods of testing lead linings and welds; lead bonded to steel, usually referred to as bonded of "homogeneous" lead; lead-covered copper or steel heating coils; and the use of acid-proof brick with a lead interlining. Little has been published to show what these improvements are, where they can be used, and how it's done. So here, brought together for the first time, are the details.

Sheet Lead Construction

Lead rolled into sheet and supported in a steel or wooden framework (cage construction) or a steel or wooden shell lined with sheet lead (lead lined construction) are the two principal methods of sheet lead construction. Actually, there are probably as many modifications as there are applications for both types of construction. They are the oldest methods of using lead as a material of construction, but still represent the major part of all the lead used by industry for handling corrosives.

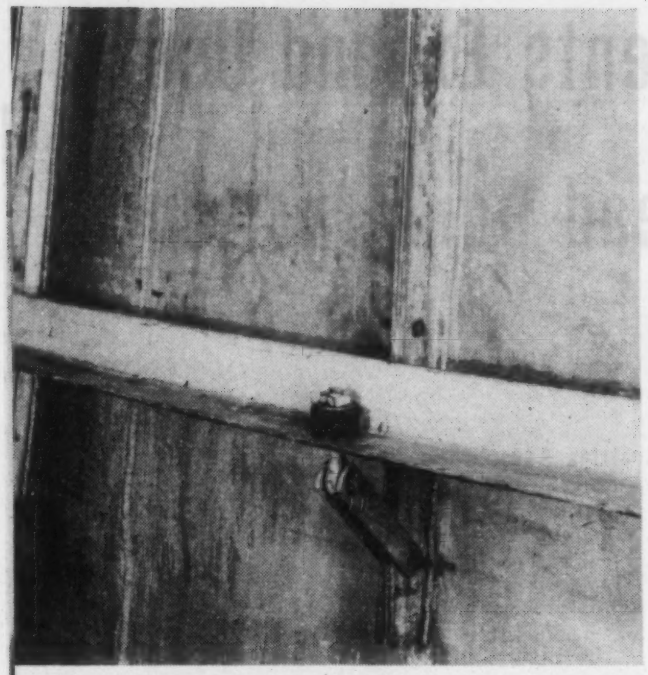
Sheet lead construction is ideal for the storage of corrosive chemicals, and is generally regarded as the method which requires the least capital outlay. Should repairs be necessary, they are easily effected in the field, and once the vessel's useful service life has expired, the lead can be reclaimed as scrap and sold at the highest relative rate of any of the common metals. Sheet lead can easily be assembled and welded in the field with the aid of only a lead burning torch. Tanks of great variety, both as to design and usage—pickling, chromium and copper plating, anodizing, acid storage, manufacture of a wide variety of chemicals, etc.—are among the common applications of sheet lead linings.

Cage Construction—The first chambers for the manufacture of sulfuric acid were of cage construction: simply large sheet lead boxes supported by timbers. Acid chambers today are being built with lead walls supported in a special steel framework that permits the metal to move freely with changing temperature. A detail of the Mills-Packard system for suspending the lead while at the same time permitting freedom of movement is illustrated.

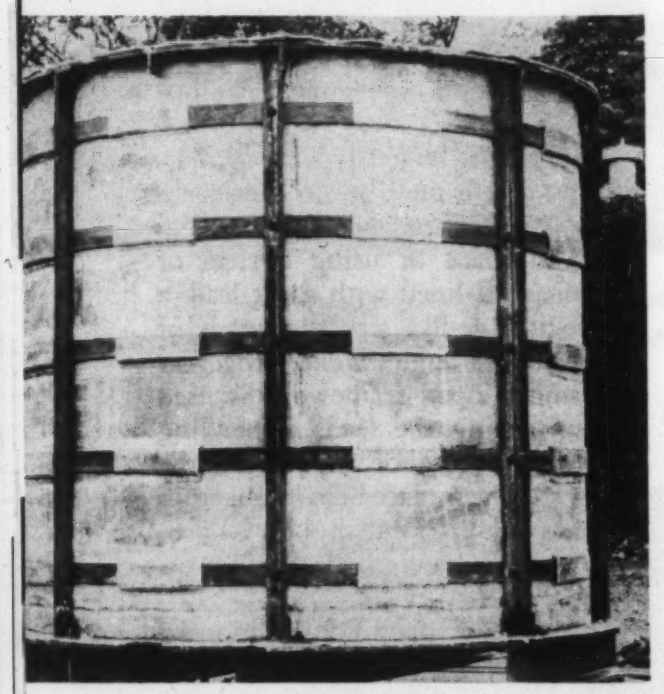
The cage or basket type of support is by no means new, but its merits are still not appreciated by many potential users. In place of using a steel or wooden shell lined with sheet lead, a basket or cage-like structure made of steel flats and angles welded together to form an open framework is used for supporting the lead. Depending upon the height of the vessel, the straps are often placed closer together at the bottom than at the top to give extra support where hydrostatic pressure is greatest.

This type of open construction in which the lead is fully exposed to the atmosphere provides an extremely effective and inexpensive method for cooling liquids which are received hot or where heat is generated by reaction, such as in battery acid dilution. Heat within the vessel is dissipated rapidly to the atmosphere by air convection and radiation.

Cage construction offers several other advantages over solid steel tanks as long as high pressure or vacuum is not encountered. The spacing between the straps permits a leak to be seen immediately. Furthermore, it can be repaired from the outside in a matter of minutes. If the size of the vessel calls for extra support, internal strapping, which of necessity must pierce the lead lining in order to be fastened, can be eliminated by using the cage-type construction. Instead, strips of lead can be burned from the outside over the horizontal steel straps and thus support the lead externally, as



Mills-Packard system of freely suspending lead side walls on modern sulfuric acid chamber.



Cage-type tank construction with strips of lead burned from outside over horizontal steel strips.

shown in the illustration.

Other advantages of cage construction are lower material costs and often easier assembly in the field, the handling of bulky and heavy steel sheets being eliminated.

Lead Lined Construction—Sheet lead-lined wooden or mild steel tanks are in common use and have been for many years. Storage vessels for corrosives, nickel, chromium and copper plating tanks, anodizing tanks, tanks for electrolytic refining of lead, zinc and copper, chemical reaction vessels and pickling tanks are all common examples of equipment lined with sheet lead. Lining thicknesses usually range between 8 and 16 lb, sometimes two or more different thicknesses being used in the same vessel, such as in areas subject to erosion or where greater strength is required. Either existing vessels or specially constructed ones of concrete, wood or steel can be readily lined with lead to make them suitable for handling corrosives.

In small storage vessels the lining is hung from the top without any strapping. More often it is provided with additional support by any of the means described below. Generally in the form of strapping, extra support is resorted to when fluctuating temperatures, fatigue or stress corrosion must be considered. In deep tanks, because of the high density of lead (0.410 lb per cu in.), loose linings must be strapped to overcome the effect of gravity. In practice, the optimum height of a loose lead-lined vessel without benefit of any support from strapping rarely exceeds 10 ft, depending upon the weight of lead. Good vertical strapping practice is to place the straps about 18 in. apart and no more than 24 in.

Fastening the straps used to support loose sheet lead linings has been simplified by a recent innovation making use of automatic stud welding. A threaded stud can now be butt-welded directly to the inside of the shell with a special gun into which the stud is loaded. The stud can be welded directly through pre-cut holes in the lead or between two lead sheets where they butt together. Half-oval steel strapping is slipped over the threaded stud and on top of the lead. The top of the strap is recessed to receive the fastening nut (see drawing). After bolting the strap, a lead strip is placed over the steel and welded securely on each side to protect the steel from corrosion. Studs are usually placed on 18-in. centers; occasionally 12-in., but never more than 24-in.

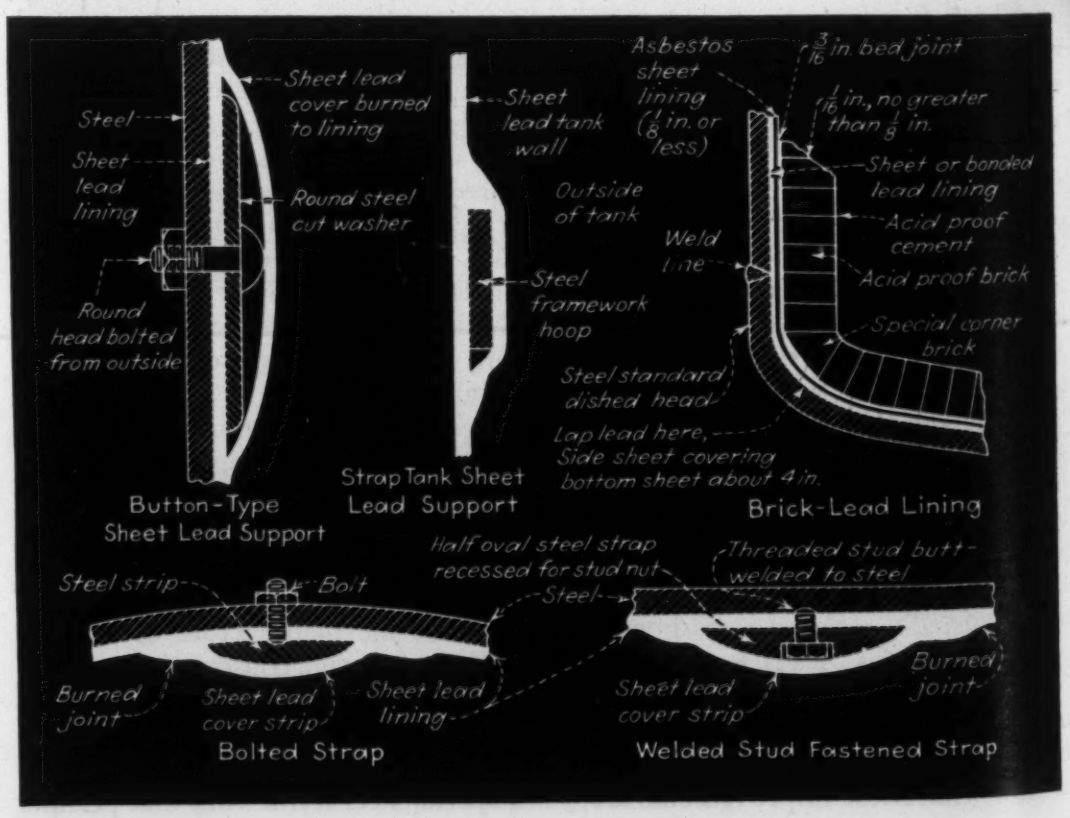
Occasionally it is advantageous to use a large steel cut washer and a roundhead bolt to fasten sheet lead to a steel or wooden shell. The bolt and washer are covered with a lead cap which is burned to the lining. This tends to distribute the load over a large area and thus aids in minimizing fatigue. The bolts used in this manner are evenly spaced over the entire lining at about 18-in. centers. This method of support is shown in the drawing.

Sheet lead for lining all types, shapes and sizes of chemical equipment usually comes in rolls ranging from 8- to 12-ft wide and up to 60-ft long, depending upon the thickness of the sheet. Twenty feet is generally considered a standard roll. Thickness varies from 1/80 in. to 2 in., or measured in the parlance peculiar to the lead industry—¾-lb to 120-lb (lead 1/64-in. thick weighs about 1 lb per sq ft and is designated 1-lb). In chemical construction lead weighing less than 8-lb is rarely encountered.

Testing of Lead Linings and Welds

A nondestructive method of testing

Drawing showing various methods of modern lead construction.



Burning bar method of lead bonding. Area ahead of men has been bonded.

lead linings and welds requiring no electrical equipment and involving only the expense of the chemicals used was recently placed on the market. The new process is used for inspecting the surface of metals and detecting any openings, such as cracks, laps, cold-shuts and porosity. Discontinuities are indicated by bright red lines, dots or blotches on a white background.

The process involves the use of three liquids—penetrant, developer and cleaner—which can be sprayed, brushed or dipped on the surface to be inspected. First the surface is cleaned, then covered with the penetrant, which is left on for 5 or 6 min. A gallon of penetrant will cover an area of approximately 3000 sq ft. After removing the penetrant with the cleaner, the developer is applied. The red penetrant will remain in any crevices until it is drawn to the surface by the action of the white developer. A red line or blotch indicates a crack or cold-shut; a series of red dots in a line indicates a tight crack, cold-shut or partially welded lap. Tiny hairline cracks which appear when lead has been overstressed, particularly under corrosive conditions, can be detected by this method.

Bonded lead linings described below can be tested by either the above method or by this one: brush on a solution of 50% hydrochloric or muriatic acid and allow to stand for 24 hr. The presence of pinholes will be indicated by rusty discoloration. After marking such spots the entire surface is washed with water and repairs made where required.

Another leak detection method that has also been used on lead is based upon a fluorescent penetrant instead of a colored dye penetrant. Surface discontinuities are indicated by this method in much the same manner as by the dye penetrant method described above. A fluorescent penetrant is applied by brushing or spraying and then removed by a water wash, after 5 to 15 min. Developing powder brings out the penetrant, and observation under a "black light" reveals any discontinuities.

Brick and Lead Linings

The handling of corrosive slurries and other combinations which both corrode and erode most materials of construction have led to the develop-

ment and practical acceptance of brick and lead lining, *i.e.,* a steel shell lined with lead, with or without a layer of asbestos sheeting followed by a layer or two of acid-proof brick set in suitable acid-proof cement.

Brick and lead lined vessels are recommended, particularly where any of the following conditions prevail:

1. Abrasion or erosion is a factor.
2. The vessel operates under high pressure or vacuum.
3. Severe corrosive conditions are encountered. (For example, where acids and alkalies must be handled in the same vessel.)

Brick linings alone are always somewhat permeable, due to the inherent porosity of the brick and the inability of the bricklayer to secure a continuous film of cement between and in back of the brick. No cemented conglomerate can be as impervious to liquids as can a metal.

A lead lining acts as an impervious barrier between the shell and the brick so that any corrosive seepage through the brick lining is retained by the lead, thus preventing damage to the steel shell. The lead and brick linings are then complementary to each other and serve as a particularly effective type of construction.

In building a brick and lead lined steel tank, the tank should be built to support the weight of the entire structure. Bottoms should be dished where pressure is involved and the welds performed at or above the bottom edge (see drawing).

A lead lining is applied next after removing all burrs or other projections on the inside of the tank which might cause injury to the lead. Chemical grade 8- or 10-lb lead is usually adequate and has found most application. Eight- or 10-lb lead is 1/8 or 5/32 in. thick. It should be lapped over the top edge of the vessel to prevent seepage between the lining and the steel, the side sheet extending down about 4 in. over the top of the bottom sheet. They should be welded together around the entire exposed edge. In very large vessels or at high operating temperatures, it is advisable to strap the lead to the shell.

Under severe operating conditions bonded lead linings are employed, in which case lead of greater thickness is generally used. Because the initial cost is essentially that of the bonding operation, using thicker lead adds little, proportionately, to the total expense involved but it does make for increased service life.

After installation, the lead lining should be tested for leaks in the manner described elsewhere in this article. After the lead has been installed and tested, a layer of asbestos sheeting or some similar material 1/16 to 1/8 in. thick is added to act as a cushion between the brick and the lead, protecting the lead against abrasion during expansion and contraction.

Finally, the vessel is lined with one or two courses of brick, the brick selection depending upon several factors: the degree of acid insolubility required, minimum allowable porosity, and the degree of thermal shock involved. The thickness of the brick is determined by the dimensions of the vessel, the amount of mechanical abuse anticipated, and the thermal insulation required. Brick size is commonly 9 by 4½ by 2½ in., though other sizes and special shapes are available.

Brick in two courses is laid so that the wall and the floor courses can be keyed in and joined with a minimum of cement, usually a $\frac{1}{16}$-in. layer, and no greater than $\frac{3}{16}$-in. The bed joint (between the brick and asbestos or lead) is about $\frac{1}{8}$-in. thick. Classes of cements are considered on the basis of desired corrosion resistance, temperature, erosion and porosity, plus the economics of cement and installation costs. Acid-proof cements available on the market include silicate cements, sulfur cements, phenolics, furfural alcohol resin base cements and modified phenolic resin base cements. Litharge-glycerin cement (80 to 100 cc of glycerin per lb of litharge) is occasionally used, particularly in the paper making industry, where its excellent resistance to sulfurus acid liquors is utilized. It has good water resistance, withstands attack by nonoxidizing acids, and can by used safely up to 350 F.

Bonded Lead Linings

Combine the corrosion resistance of lead with the strength of steel and, in effect, you have what has been achieved with a bonded lead lining. Bonded lead is simply a layer of lead bonded to a steel plate so as to form a homogeneous or integral structure. The thickness of the layer, depending upon the ultimate use, ranges from $\frac{1}{8}$ to $\frac{3}{4}$ in., $\frac{1}{4}$ to $\frac{3}{8}$ in. being common. By literally anchoring the lead to steel at all points of contact, relative movement between the two metals is minimized.

Bonded lead-lined vessels are recommended for use where any of the following conditions prevail:

1. Fluctuating temperatures are encountered.
2. High temperatures.
3. The vessel operates under vacuum.
4. Vibration or physical shock are encountered.
5. Heat transfer is important, such as in jacketed vessels. (No insulating layer of air exists between the shell and the lining.)

The advantages of bonding lead to steel have been known for many years, but the development of efficient and less expensive methods for accomplishing this have, until recently, been lacking. Two methods that have been put into commercial practice for manufacturing bonded lead linings on steel are described below.

With both methods the first step is preparation of the steel prior to bonding. The usual procedure is to clean it first by shot blasting so that an oxide-free surface will be exposed. This can be followed by pickling, usually in a 10% solution of sulfuric acid, and rinsing with water. If the bonding is done immediately after shot blasting, no pickling is required. Flux is then applied to the working area where the bonding is to commence and immediately prior to the bonding operation. Zinc-ammonium

***Lead burner burning lead cover** over strap for supporting sheet lead lining. Note typical tools used.*

chloride and stannous chloride are two fluxes commonly used, in addition to several proprietary fluxes for which certain advantages are claimed.

Burning Bar Method—This method begins with preparation of the steel in the manner described above either as a unit or in sections. Then lead is melted from a "burning bar" onto the prepared steel surface by using a hand operated lead burning torch. This procedure is used to advantage in bonding small areas and irregular shapes. After building up the lead layer to slightly more than the thickness desired, the lead is peened, scraped, or its surface otherwise made uniform.

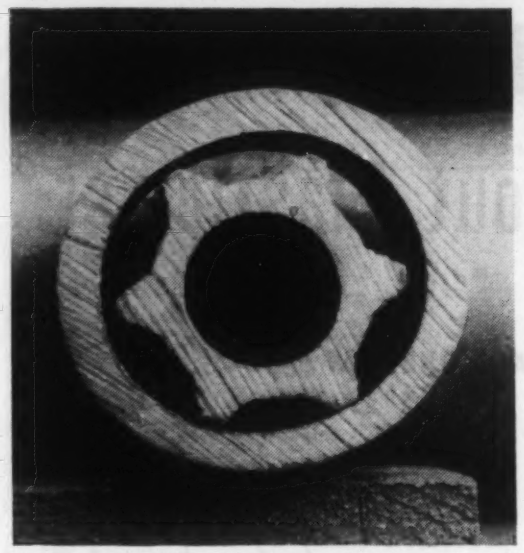
Pouring Method—Improvements in methods of pouring lead on steel have made this method of bonded lead manufacture an efficient and also less expensive one. The method consists first of preparing the steel surface, usually in the form of a large plate by the methods described above. Molten lead is then carefully poured on the heated steel surface. After solidification, the steel with the bonded lead lining is often rolled in a conventional rolling mill to compress the lead and curve it to shape. On heavy curved sections or irregular castings, the lead is cast in overlapping sections by partially rotating the vessel after each pouring. In either case, the lining is then scraped with special tools until a uniform thickness is obtained. Peening may or may not precede the scraping.

Lead Piping and Coils

Lead is readily extruded into a variety of shapes and sizes, and large quantities of extruded lead are used in the plating, chemical and related industries principally as pipe for conducting corrosive solutions and as cooling or heating coils submerged in corrosives. Sizes are limited only by the extrusion equipment available, and can include wall thicknesses of any size and cross-sections of practically any shape. The largest commercial lead extrusion currently made is 12 in. in inside dia.

Joints in lead pipe can be of the Van Stone type made by butting together flanged sections and securing them with two bolted cast iron or steel slip-on flanges. They can also be butted together and welded. In the case of vertical pipe, sections are joined with a "cup" joint. In this type joint, the lower section of pipe is flared out and the upper beveled to fit into the flared end where it can be welded.

Lead pipe coils have found widest acceptance for cooling purposes,



Cross-section of heat exchanger coil consisting of one lead pipe within another.

chiefly because of lead's corrosion resistance and the ease with which it can be formed. Lead coils usually are helical in shape but can take other forms and are constructed of extruded lead pipe. Flat coils for the ends and bottoms of the tanks are also used. Pipe extruded with a fluted or ribbed cross-section for greater surface area is commercially available.

One of the latest lead coil developments is a heat exchanger consisting of two lead pipes, one within the other. The larger pipe has a 2-in. I.D. with ¼-in. wall and is extruded from 6% antimonial lead. The inside pipe made of soft lead is 1-in. in dia with a ¼-in. wall at the thin portion. The exterior of the inner pipe has been extruded in the shape of a six-pointed star to provide extra support and also to retain concentricity. The pipes were designed so that the area of the space between the two is approximately equal to the cross-sectional area of the inner pipe. After extrusion the coil was assembled by inserting the smaller pipe into the larger and coiling both into units 11 ft in circumference and 27 coils high (about 7 ft). The unit performs the dual function of cooling a solution circulating between the two pipes and heating another solution circulating through the inside pipe.

Because of lead's weight, it is frequently advisable to support it over long spans either with strap hangers, by laying it in steel channels or by using lead-lined pipe. Steel or iron pipes lined with lead are used to advantage when pressures exceed 50 lb of steam (298 F) or the expense of supporting the pipe by other means is disproportionate. Lead-lined pipe is commercially available from 1 to 12 in. in dia, the lead lining thickness ranging from 5/64 to ⅜ in.

Bonded and Lead-Covered Pipe

Bonding techniques similar to those described above have been utilized in the manufacture of lead-lined steel pipe and lead-covered copper pipe. In all cases the purpose is the same: to utilize lead's corrosion resistance in combination with the strength of steel or copper. In making bonded lead pipe a length of steel pipe is first cleaned and fluxed. Then molten lead is cast-on in sections by rotating the pipe. A second method uses a length of extruded lead pipe which is inserted inside a properly prepared pipe of steel. The ends of the lead pipe are sealed and steam pressure applied to expand it against the outer pipe. Pressure is raised until the temperature reaches the point where bonding takes place between the lead and steel, aided by pre-tinning the steel with a thin solder film.

Solder-bonded lead-lined steel pipe is recommended when design or operating conditions involve temperatures up to 250 F, vacuum, high pressure, vibration or physical shock and, of course, the handling of corrosive chemicals. Pipe sizes range from ½ to 12 in. I.D., with the lead lining thickness either ⅛, 3/16 or ¼ in.

Lead-covered copper and steel pipe is made somewhat like bonded lead-lined pipe, except that the lead layer is on the outside instead of the inside. The pipe in lengths of about 10 ft is cleaned and fluxed and mounted centrally in a circular split mold. Molten lead is poured around the pipe until it is completely covered. The pipe is finished by drawing it through a drawbench to bring the lead down to the thickness desired. By other techniques, continuous lengths up to 100 ft can be made.

Lead-covered copper coils can be operated up to 150-lb steam pressure, while ordinary lead steam coils can operate successfully only up to 50-lb steam pressure. This is the reason why lead-covered copper has found such wide acceptance for use as heating coils. Copper absorbs and transfers heat with the greatest efficiency of the common metals and because lead is bonded directly to the copper with no air interface, heat transfer in lead-covered copper piping is maintained at its highest value. Because the physical strength to withstand high steam pressures is provided by the copper, it is practical to keep the thickness of lead covering at a minimum; thus, the combined thickness of copper and lead is materially less than the wall thickness of lead pipe for the same application.

New Rigid Vinyl Processed Without Plasticizer

A NEW MATERIALS PREVIEW

● A HIGH MOLECULAR WEIGHT polyvinyl chloride resin, Geon 404, which is processed without the aid of a plasticizer on conventional plastics equipment, has been introduced by B. F. Goodrich Chemical Co. This new rigid vinyl, which should not be confused with *hard vinyl* produced by reducing plasticizer content, can be processed easily by deep drawing or vacuum forming, extruding and calendering. Extreme toughness, higher temperature softening point, superior electrical properties, and resistance to chemical attack are important properties.

The great strength, light weight and breakage resistance of rigid polyvinyl chloride make it suitable for instrument, typewriter and business machine cases, luggage, tote boxes, and similar applications. It can also be drawn and molded for military topographical maps.

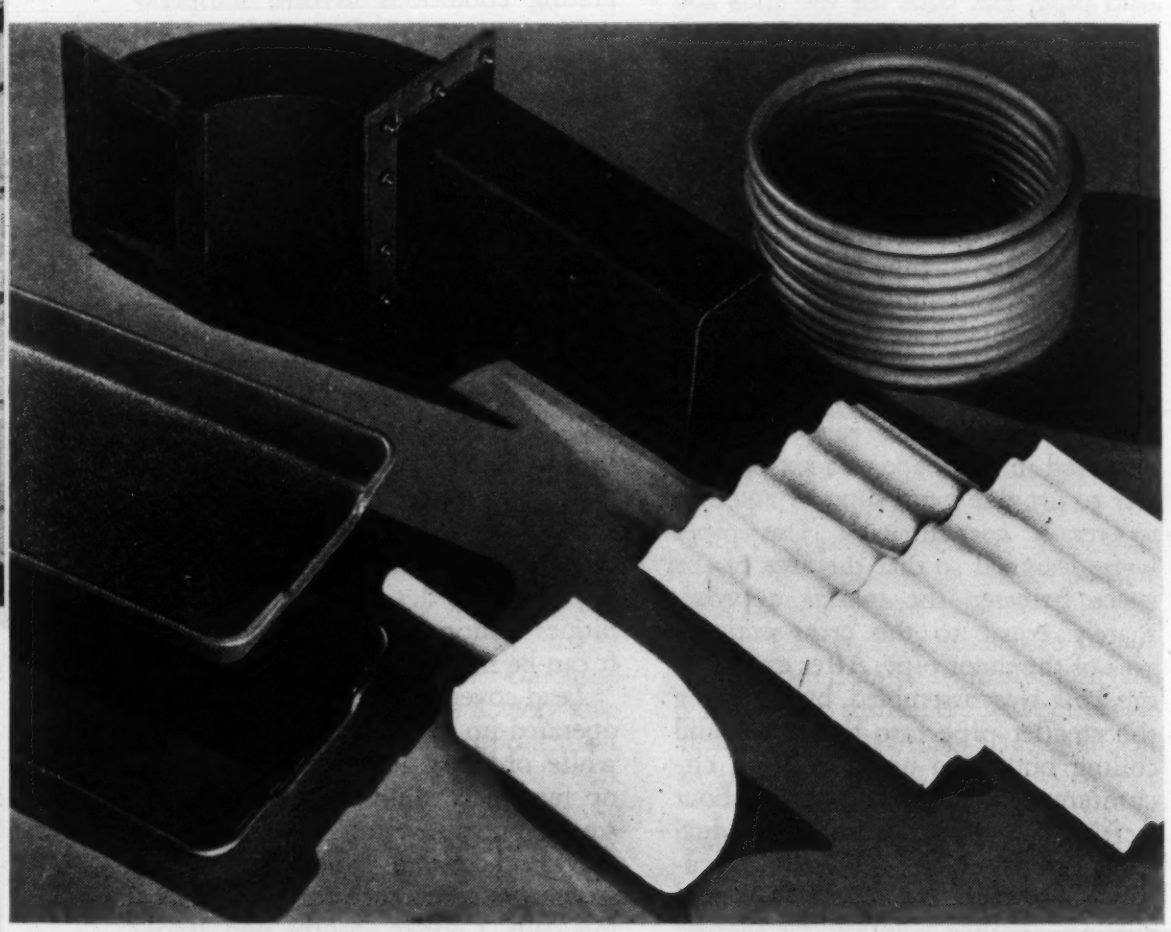
Rigid polyvinyl chloride's chemical resistance suggests use in corrosive areas. The rigid sheets can be welded by the hot gas technique and fabricated into fume hoods and duct work for which most metals are unsatisfactory. Corrosive chemicals can be handled in unsupported tanks of the new vinyl or in metal containers lined with it.

Electrical properties unattainable with plasticized polyvinyl chlorides are present in rigid vinyl insulation based on Geon 404. Typical applications are on weather-proof line wire, television lead-in wires, military radio hook-up wire, coaxial cable jackets, and Navy cables of reduced diameter which require a nonextending jacket at elevated temperatures.

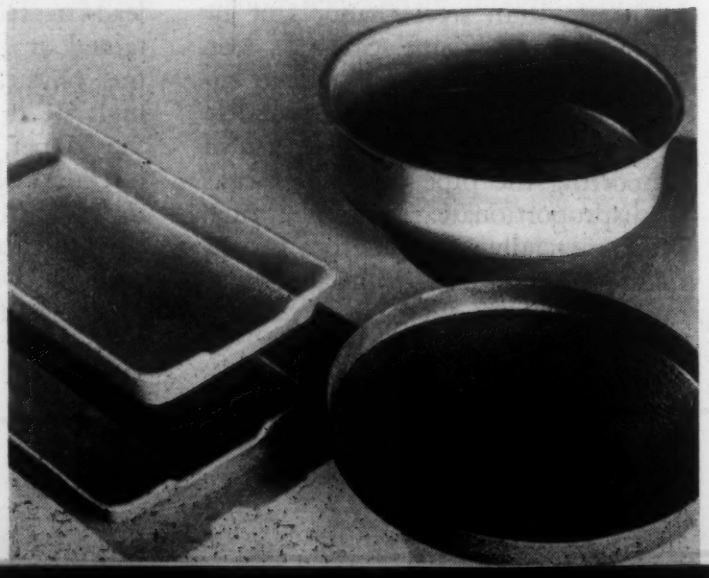
Although there are a multitude of present day uses which require soft pliable plasticized vinyls, certain properties of polyvinyl chloride are lost when plasticizers are added. The acid, alkali, solvent, electrical, heat and light resistant properties are inferior to the original polymer. The new unplasticized rigid vinyl retains the unmodified properties of the pure polyvinyl chloride.

Unplasticized resins are normally produced by copolymerizing vinyl chloride with small amounts of various other monomers. By this method resins are produced which can be processed without plasticizers, but the fundamental properties are not normally equivalent to those of straight polyvinyl chloride. The usual comonomers also act as modifiers, which result in lower molecular weight resins and, therefore, reduce the heat distortion point, flexural strength, tensile strength, shock resistance and electrical resistance, as well as the chemical and solvent resistance. Geon 404 eliminates these undesirable features and retains the characteristics of the high molecular weight straight polyvinyl chloride resin.

Although the old type unplasticized polyvinyl chloride has exhibited superior chemical and physical properties, it has enjoyed only a small portion of the rigid plastics' market. Difficulty in processing has been the primary reason for its limited use. Most fabricators in this country are convinced that rigid polyvinyl chloride cannot be calendered, extruded or molded satisfactorily without the addi-



Experimental end products made from Geon 404 include decorative corrugated sheets, corrosion resistant hoods, trays, pipe and scoops.



Trays and containers of the new rigid vinyl are used where chemicals would corrode metals. Excellent insulating properties are another feature.

tion of some plasticizer.

In Germany, straight unplasticized polyvinyl chloride sheets and tubes have been used for large scale industrial fabrication. During World War II this was considered an essential industry since many of its applications supplanted critical metals. The high quality resins produced in this country, however, were generally considered to be too dry and tough, even at high temperatures, to be usable without plasticizer. The advent of the new resin which can be processed on conventional equipment without plasticizer promises to be a source of development for the plastics industry in this country.

Processing Characteristics

Banbury mixing, milling, extruding, calendering, injection molding and compression molding are the most common types of processing. Although it is possible to process some rigid vinyls directly into usable forms by extrusion, molding or calendering, it is not recommended for most applications. It is generally more satisfactory to do the initial work in the banbury or on a mill where the proper stabilizers, lubricants, fillers and colors can be added. The mechanical working that is received here is more important than it is in the soft plasticized stocks which flow and knit together much faster. After milling, it is necessary to cut the sheets into small pieces for further processing, but rigid vinyls are so tough and horny that it is impractical to granulate after the stock is cold. Since the batch hardens very rapidly after removal from the mill rolls, it is difficult to handle large sheets and keep them hot enough for cutting.

A large tuber which will extrude the unplasticized powder into small rods, and a chopper to cut them into short lengths, promise to be the best method for making granules. It is usually necessary to pass the rods through a short water bath to chill the surface to prevent them from sticking together.

All vinyl compositions require careful temperature control for proper processing. This is especially true when the compound contains no plasticizer. They require a relatively high temperature which must be accurately controlled between the softening point and the decomposition temperature. There is no wide range of allowable temperatures such as are permissible with other resins like polyethylene, polystyrene and nylon. This has been a serious handicap to many processors who were unable or unwilling to meet the required conditions. The problem is further complicated by the fact that unplasticized stocks are subject to tremendous frictional heat build-up on processing. The newly developed Geon 404 polymer will make processing conditions less critical.

The temperature requirements for rigid vinyls depend on the type of polymers used. In general, the processing temperature for an unplasticized resin is only 20 to 30 F higher than for the same resin with 50 parts of plasticizer. Geon 404 can be milled easily at 300 F. One of the early mistakes in rigid vinyl processing was the belief that a very high temperature is required. This aggravated the problem of stabilization and caused excessive sticking to the mill rolls.

Although Geon 404 has been produced in commercial quantities and processed on production equipment, it is not yet available in large quantities. Under present emergency conditions, the new resins will be available only for the development of military and other essential applications.

Electrical Properties of Wire Insulation

Properties	Plasticized Vinyl (Standard Wire Insulation)	Rigid Vinyl (Geon 404)
Insulation Resistance (1/32-In. Wall), megohms per 1000 ft at 122 F	50-100	20,000-35,000
Dielectric Strength (v/mil), 77 F in Water		
1/64-In. Wall	700-900	1200-1300
1/32-In. Wall	600-800	800-1000
Power Factor—1000 Cycles at 77 F	0.07-0.09	0.015-0.02
Dielectric Constant—1000 Cycles at 77 F	5-7	3.0-3.2
Loss Factor—1000 Cycles at 77 F	0.35-0.6	0.045-0.064
Power Factor—1000 Cycles at 122 F	0.09-0.11	0.012-0.017
Dielectric Constant—1000 Cycles at 122 F	6-8	3.2-3.4
Loss Factor—1000 Cycles at 122 F	0.54-0.88	0.038-0.058

Physical Properties of Wire Insulation

Properties	Plasticized Vinyl (Standard Wire Insulation)	Rigid Vinyl (Geon 404)
Tensile Strength, Psi	2000-3000	6500-8500
Elongation, %	200-300	15-25[1]
Hardness (Durometer)	65-95A	82D
Specific Gravity	1.3-1.4	1.35-1.45
Low Temp. Flex—2 hr (6 Turns Around 0.3-In. Mandrel) Passes	-30 to -50 F	-70 F
Heat Shock—1 hr at 248 F	OK	OK
Air Oven Aging— 7 days at 212 F, % Retention of Elongation	70-90	100
Cutting Resistance (Lb through 0.032-In. Wall) 0.025-In. conductor 122 F	18.5	>66[3]
158 F	10.5	47.5
Compression Strength, at 77 F[4] (Lb/2-In. Length)	2500	8500
Deformation (1/32-In Wall, 1000 Gm Wt on 3/8 In. Foot) 1 hr at 248 F	40-50%	25%
Abrasion Resistance[2] Taber Abrader (60 D2R) 5000 rev		
Weight Loss	0.25 gm	0.085 gm
Volume Loss	0.185 cc	0.060 cc

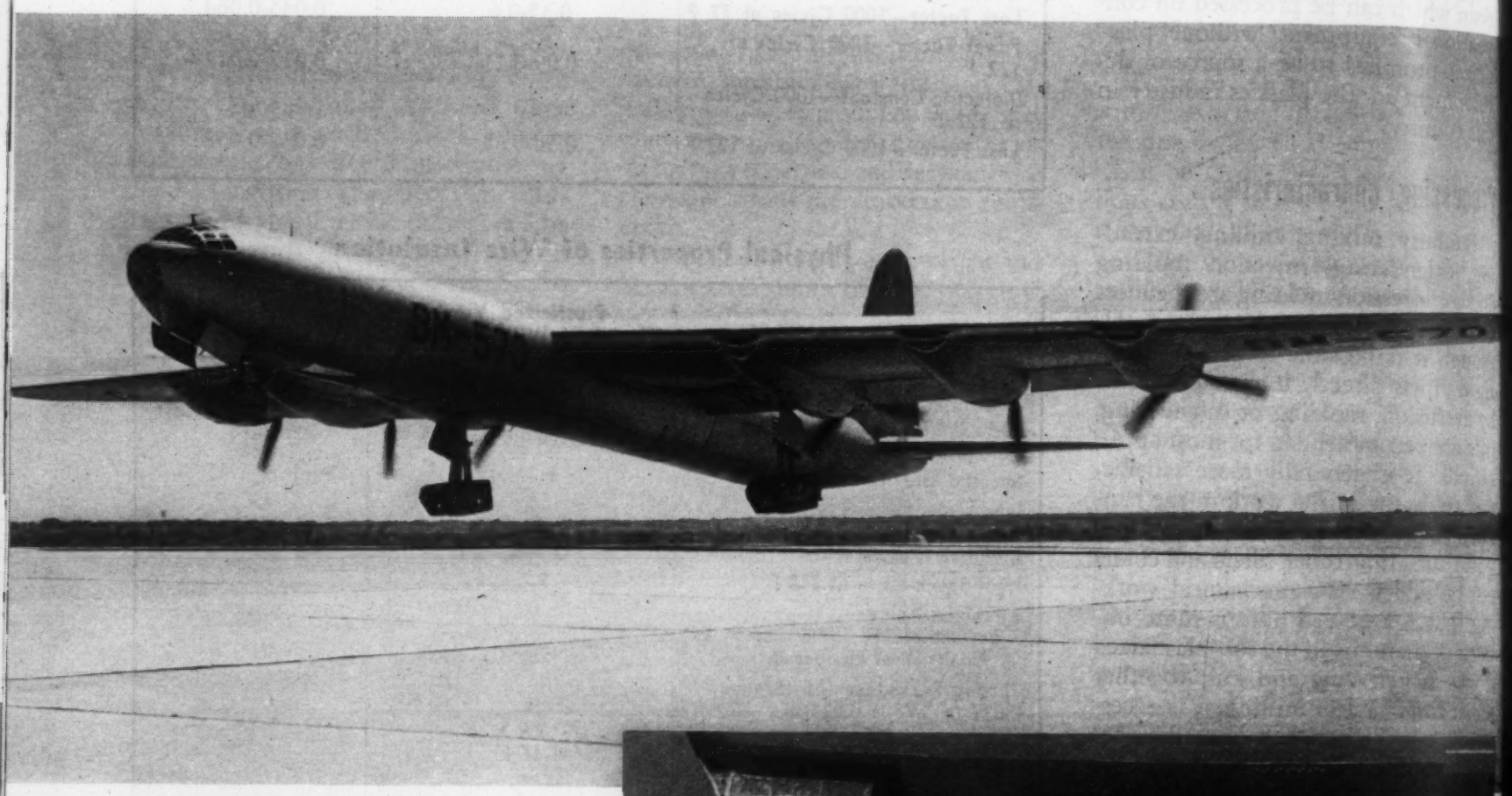
[1] Jaw separation—1 in. per min.
[2] Run on tensile sheets.
[3] Conductor broke.
[4] Compression rate 0.2 in. per min.

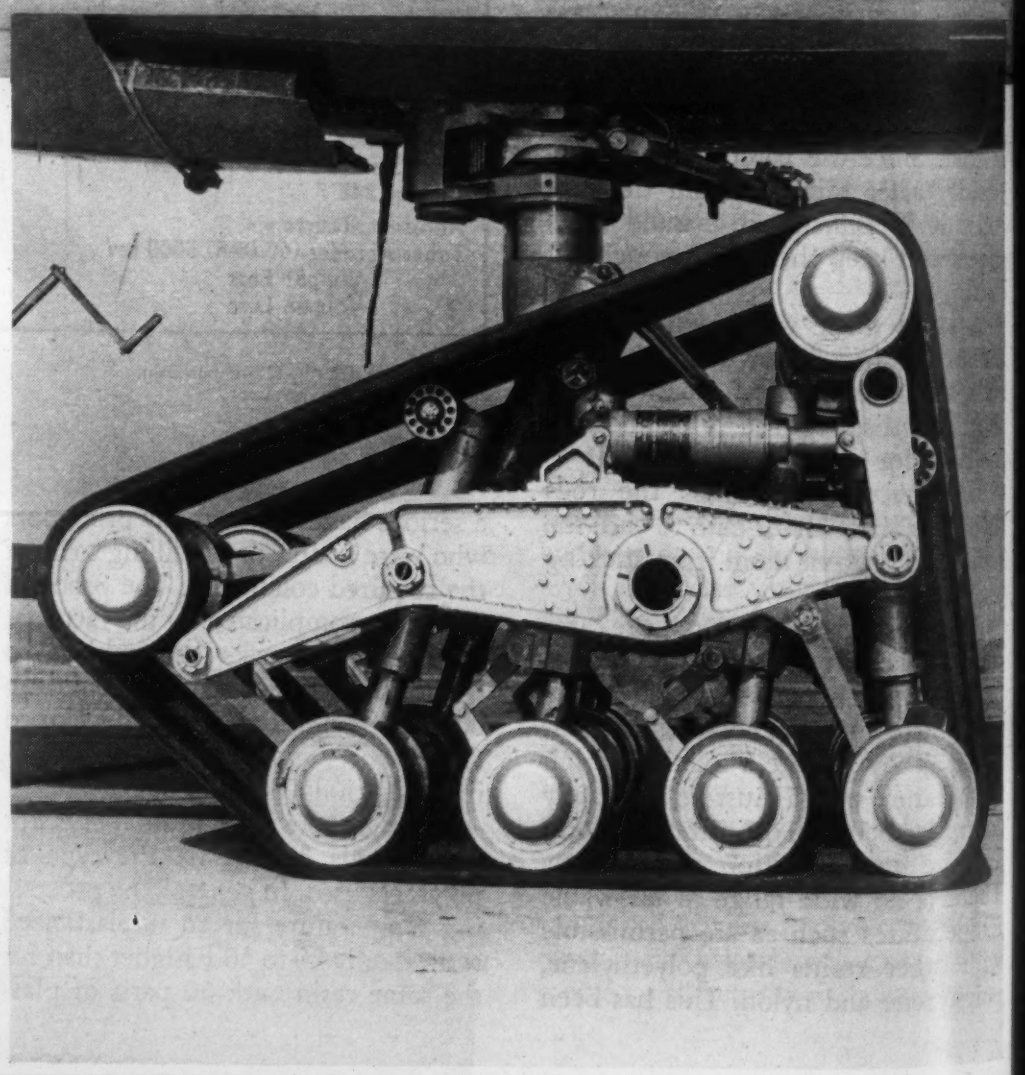
Materials at Work

Here is materials engineering in action . . .

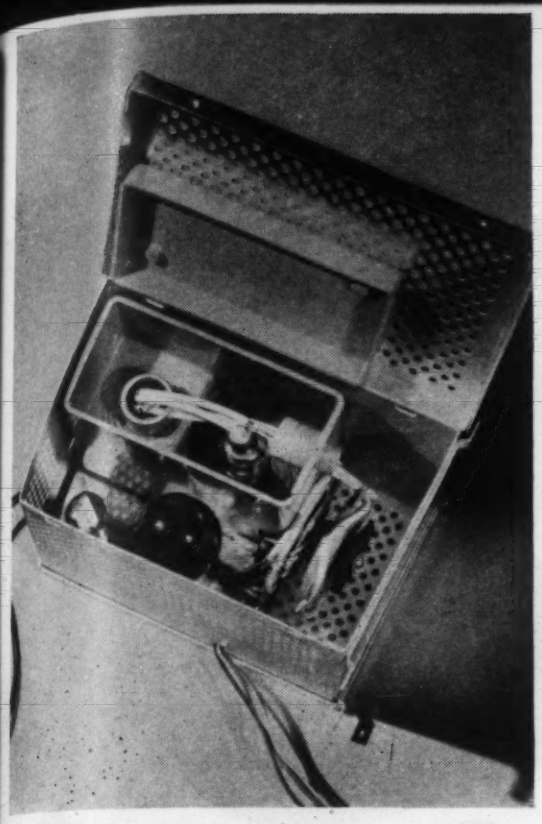
New materials in their intended uses . . .

Older, basic materials in new applications . . .



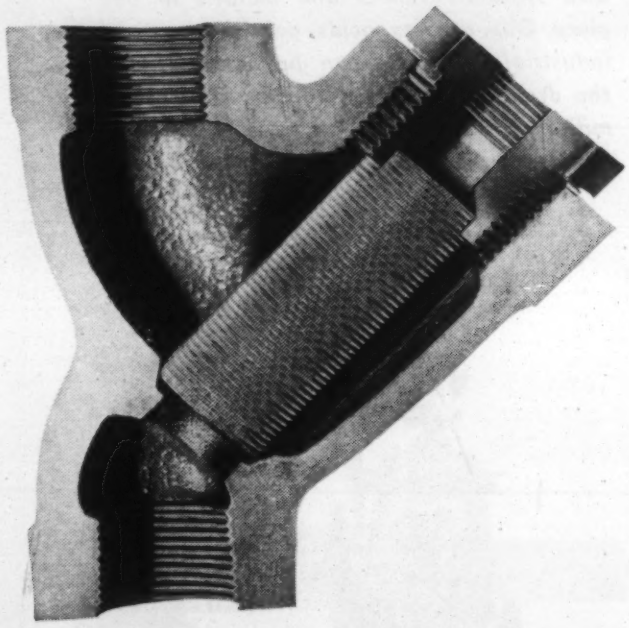


ALLOY STEEL LANDING GEAR *A new track type landing gear for the experimental XB-36 is designed for a maximum average ground pressure of 57 psi, in contrast to the 156-psi pressure exerted by the conventional wheel type gear on a B-36 of the same gross weight. The track of the new gear simply distributes the weight over a larger area. Although the track-type support is still heavier than the standard wheels, its weight has been cut by 2,000 lb by good design and by the use of a high strength alloy steel, Hy-Tuf, made by the Crucible Steel Co. of America. The typical composition of the patented alloy is 0.25 carbon, 1.40 manganese, 1.50 silicon, 1.80 nickel and 0.40% molybdenum. It can be heat treated to at least 200,000-psi tensile strength, with an Izod impact strength of more than 20 ft-lb. This combination of strength and toughness permits size and weight savings in important parts of the gear.*



PHENOLIC HOUSING *Vital to the functioning of this voltage driver developed by North American Philips Co., Inc., for their projection television system, is this internal housing molded of Bakelite insulation phenolic, manufactured by the Chicago Molded Products Corp. The low-loss phenolic material is specially formulated for high frequency electrical insulation, where low power factor, low loss factor, high resistivity, dimensional stability and low water absorption are required. This molded housing contains two amplifier tubes and a transformer, simplifying manufacturing procedures and lowering replacement costs. Originally, the voltage drivers were vacuum impregnated, oil filled and hermetically sealed, and had to be returned to the factory for repairs. No oil impregnation is required with the new units, however, because of the high dielectric qualities of the phenolic, and, in addition, the design allows tube and component replacement in the field. A major advantage of the new housing is that it contains no oil, which eliminates the danger of flamability.*

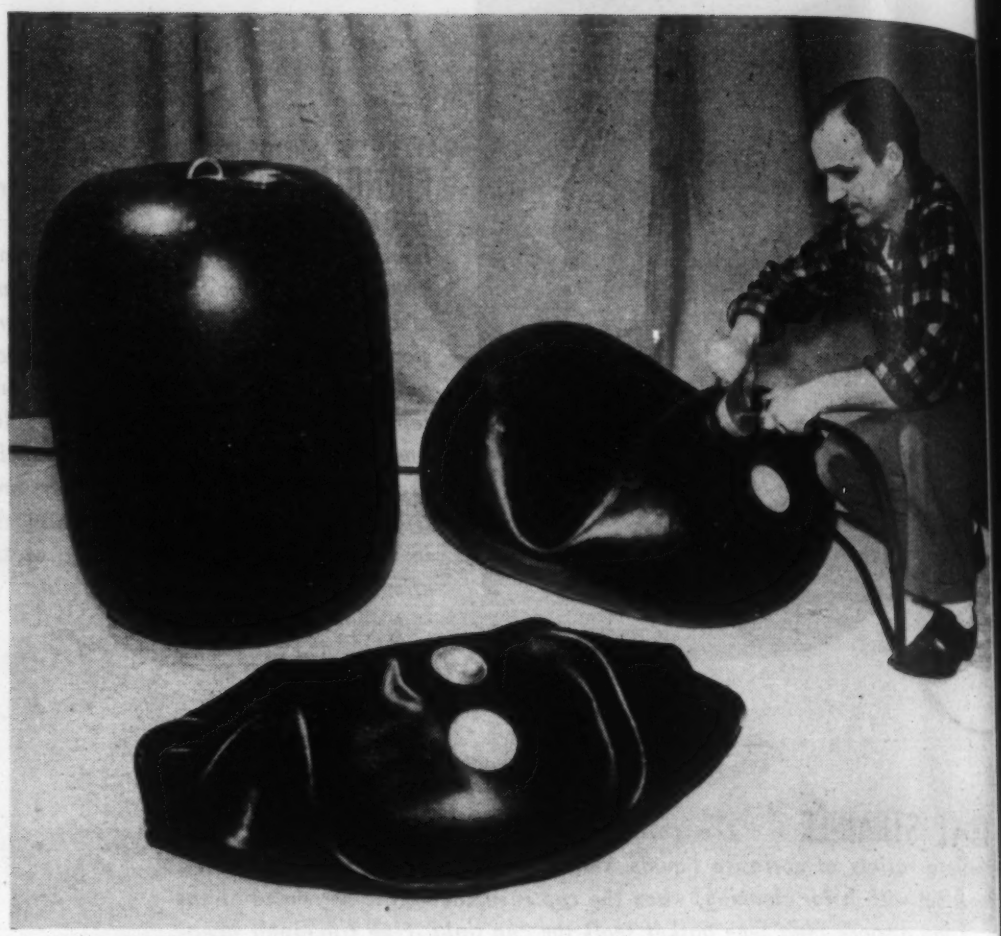
MONEL STRAINER *The Yarnall-Waring Co.'s strainer is designed to handle a variety of corrosive liquids. When the cap is unscrewed, the screw comes out with it for cleaning; when the cap is replaced, the screen re-aligns itself and a spark-plug type gasket seals the cap tight. Fine triangular openings screen out solids like rust and scale, allowing continuous flow with little pressure drop. In fabricating, monel mesh, woven from wire supplied by Driver-Harris Co., is easy to form and weld; in use, monel is applicable to most of the corrosive liquids found in industrial applications.*

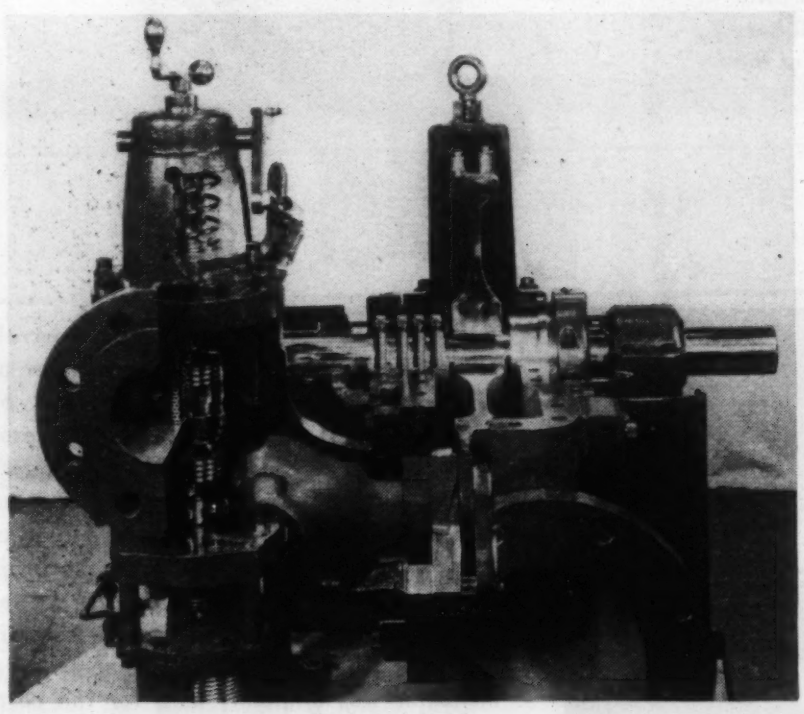


ALKYD ROTOR DISK *A 50% overall saving in cost without loss of electrical or non-tracking properties was obtained by Barber-Colman Co. by molding the rotor disks for the J. I. Case Co.'s machinery magnetos of Plaskon alkyd, supplied by the Plaskon Div. of Libbey-Owens-Ford Glass Co. The rotor, shown in the opened magneto, is being molded of alkyd because of its arc resisting properties and the good track it offers for the carbon brushes. Mineral-filled melamine was originally used for the part, but production capacity of the new alkyd mold has proved much higher than the process used with the melamine. The molder is running the alkyd in a 3-cavity compression mold on a 15-ton hydraulic press.*

Materials at Work

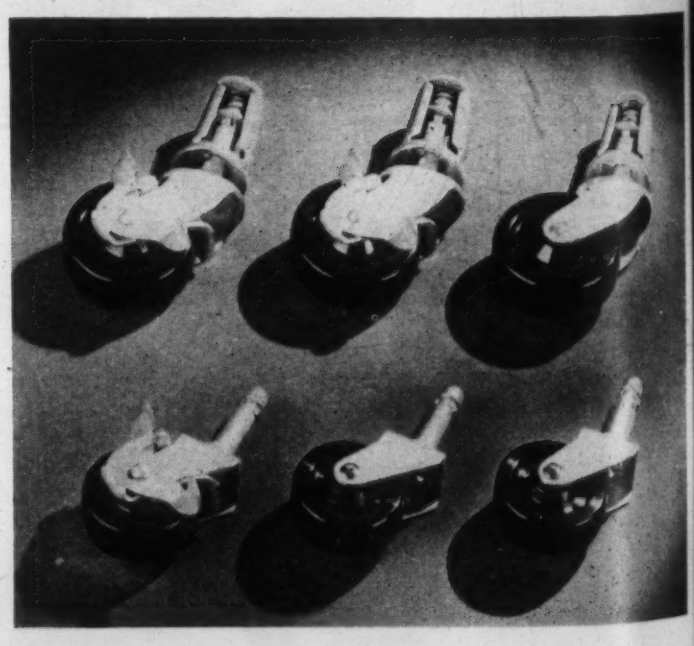
RUBBER FABRIC DRUM *A 55-gal synthetic rubber fabric drum for shipping liquids has been developed by the United States Rubber Co. The drum collapses when empty and no vent is required for filling or taking out the liquid, so that easily oxidized or combustible fluids can be handled without contact with air. A full drum retains its shape and can be rolled easily on the rounded ends. On return shipments, 2500 of the collapsed rubber drums, weighing less than 30 lb each, can be carried in a standard box car that would hold only 300 rigid drums. Since there are no inner corners or pockets, the contents can be drained completely and the inside cleaned. The drum is made of Ustex fabric, a low stretch cotton textile made by U. S. Rubber, impregnated with synthetic rubber and molded in one piece. Oils, greases, acids, paints, soaps and industrial chemicals can be handled, and the drums are believed to be practical for military air and parachute transportation of liquids.*





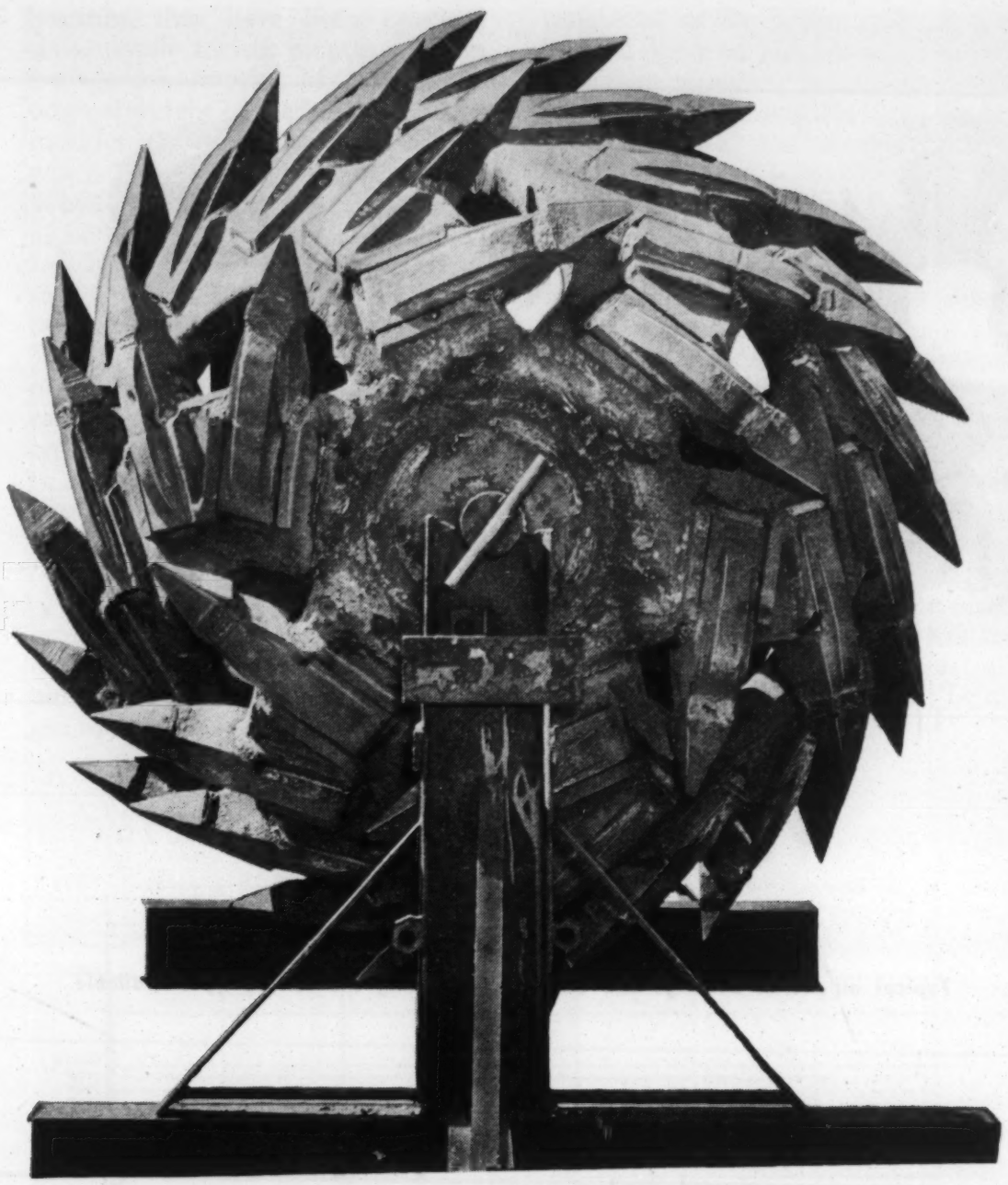
ALLOY IRON TURBINE VALVES *A new line of General Electric mechanical drive steam turbines incorporate a compact governing valve and trip throttle valve, with combined double valve seat and valve guide made of Ni-Resist, a cast iron alloy with 30% nickel. The metal was chosen to secure erosion and corrosion resistant properties, to prevent galling and seizing, and for economical production. The cost of machining the Ni-Resist was only 25% of that of the applicable stainless steel, and additional savings were made since the new castings, produced by Michiana Product Corp., cost less than stainless, which, in addition, had to be Chapmanized to make it non-galling with the Chapmanized stainless steel valve cup. Ni-Resist also offers good creep strength and growth resistance at the temperatures encountered.*

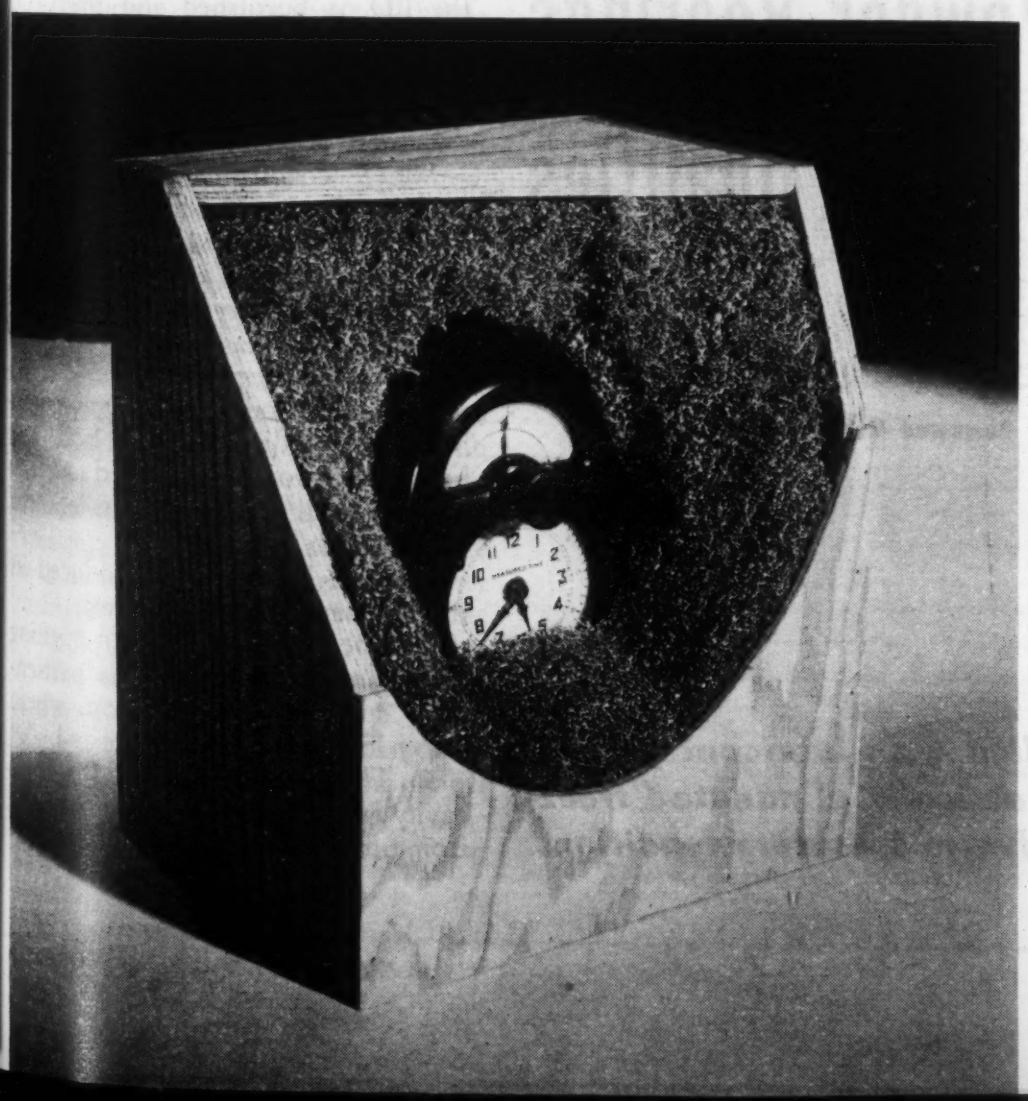
NON-TRACKING WHEELS *Caster wheels molded of Bakelite phenolic plastic for washing machines are not only durable but are also non-marring and will not streak floors. These caster wheels, molded for the Nagel-Chase Manufacturing Co. by the Banner Plastics Corp., are designed with or without brakes in 2- and 2½-in. diameters. The attractive gloss is another feature that makes for consumer appeal on washing machines and ironers.*



WELDED DREDGE CUTTER

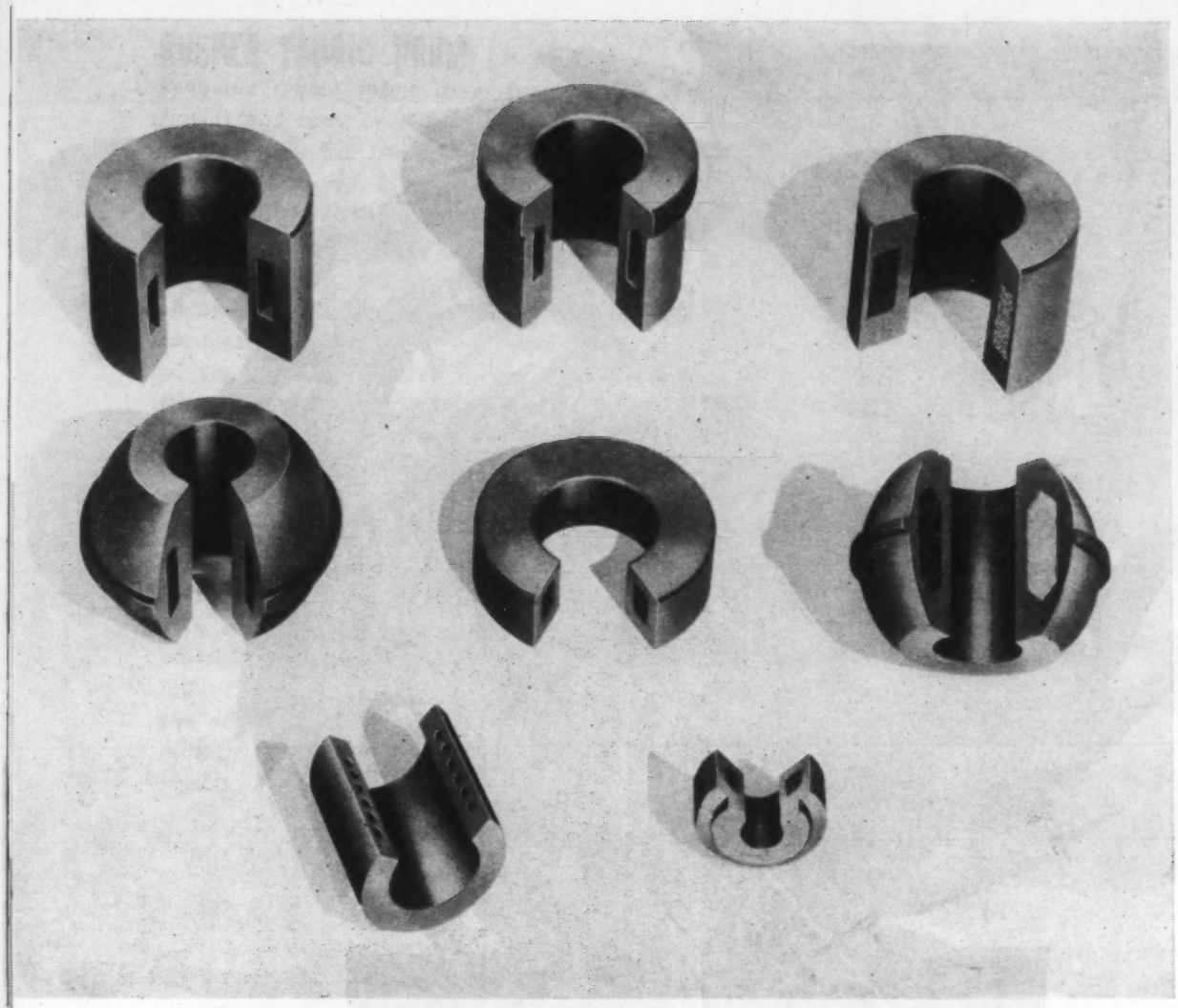
A cutter designed by the Florida Machine and Foundry Co., Jacksonville, Fla., for use with suction dredges on rocky bottoms, is made in sizes up to 10 tons. The cutter chews up the rock, which is then evacuated to the surface by the hydraulic dredge. This cutter consists of a series of curved blades fitted with heavy cutter points, attached to an 84-in. dia ring at one end, and at the other, to a hub threaded for a 14-in. dia shaft. Thermit welds, now used in fabrication in place of arc welding, eliminate the need for stress relieving, besides lowering the cost of the job. Six Thermit welds join the blades to the back ring, a stub part of each blade being cast integrally with the ring. The hub is then welded to the other ends of the blades. A total of 1700 lb of Forging Thermit is used in building each cutter.





RUBBERIZED HAIR PACKAGING MATERIAL

A rubberized curled hair or wool protective packaging material, Texlite, is being manufactured by the Sponge Rubber Products Corp. for handling precision instruments and electronic equipment. Texlite is a mass of interlaced fibers, vulcanized into a compact, non-shredding material with a 1½ to 5 lb per cu ft density range. Excellent deflection properties and recovery from compression qualify the material for use where an abrupt deceleration would bend delicate mechanisms to effect instrument calibration or alter oscillation of electronic tubes. The extent of the shock that can be effectively cushioned is controlled by thickness, density and shape. The fiber is also moisture resistant and vermin and fungus proof.



Typical oil-pocket bearings and bushings illustrating the various types available.

Oil-Pocket Metal Powder Bearings Improve Self-Lubricating Qualities

by JOHN HALLER, Vice President, Michigan Powdered Metal Products Co., Inc.

Interior cavities filled with lubricant prolong bearing life and practically eliminate "freezing" under many adverse operating conditions.

● A RECENT DEVELOPMENT in the field of powder metallurgy is the production of parts such as bearings and bushings with interior cavities which serve as lubricant reservoirs. In such parts, the self-lubricating properties of the piece are prolonged five to six times that of conventional parts of similar types.

These oil well bearings, as produced by Michigan Powdered Metal Products Co., have a continuous cavity—or pocket—of uniform size and shape inside the wall. The opening can be produced in a varied range of sizes and shapes to meet the particular requirements of the part. As grease is impregnated into the sintered metal by static pressure, it fills this pocket as well as the pores in the sintered metal body itself. The result is that, in application to bearings as an example, the increased lubricating quality of the bearing, together with a stronger bearing material, makes it possible for it to take heavier loads and practically eliminate "freezing" under the most adverse operating conditions.

Types of Bearings

Oil well bearings are normally made with a powdered iron base. They can also be produced with a powdered bronze base when that better meets the end use requirements of the part. They are sintered after briquetting. Following the sintering process, the part is impregnated with a specially-developed lithium-base grease or other lubricants and then the I.D. is burnished and the O.D. is sized to necessary tolerances. The bearing material machines in the same manner as low carbon steel, except that more relief on the tools is used.

Where conditions require it, the iron powder base bearing can be carburized using oil as a quenching medium. No draw is required. They can also be gas-cyanided or carbonitrided for increased wear. Such types of heat treating processes have been used in the production of guide pin bushings for die sets. The bore can be finished to any required surface finish, and all usual bearing tolerances can be held.

Oil well bearings are produced in three general types as follows:

1. The pocket type has an opening of rectangular shape, and is particularly suited for installation where heavy load bearings are required.

2. The sponge pocket type has a cavity which is filled with sponge iron, providing a capillary effect tend-

ing to retain lubricant for long periods. These bearings are recommended for conditions where they are subjected to heat. The pocket area is larger in this type of bearing which automatically reduces the wall thickness, putting these in the category of medium load bearings. The difference in lubricant content in the pocket type and sponge type bearings is practically negligible.

3. The modified pocket type provides a cavity made up of a number of small holes so that, where thin wall bearings are required, the structure of the bearing wall is not weakened. In all cases, the wall thickness should be a minimum of ¼ in. to maintain wall strength.

Oil well bearings can be supplied in sizes ranging from 5/16 in. I.D. up to a normal maximum of about 6 in. I.D. In some instances, bearings can be made in even larger sizes, with the limiting factor being the amount of material required to provide specified wall thicknesses.

Bearing Properties

In use, these parts have all the advantages of the commonly used oil-impregnated porous bronze bushings, plus the added advantage of greatly increased lubricant capacity. For example, in a ¾-in. bore spherical bearing, 40% of the total volume of the sphere, amounting to 12 cc, is lubricant. No lubricant reaches the bearing surface without being filtered through the porous walls, thus absolutely preventing contamination of the lubricant. Further, since all lubricant is in the interior, there is no possibility of its oxidation.

Oil well bearings have the following physical properties. Powdered iron-base bearings, not heat treated, have a tensile strength of 45,000 psi and a load carrying capacity up to 125 psi of projected bearing area. Because of the porosity of sintered metals, ordinary hardness readings do not represent the actual hardness of the metal. However, in these bearings the normal apparent hardness is Bhn 42/44 and the heat treated apparent hardness is Bhn 100/125. After heat treating, the hardness at the surface will be such that an experienced tester using a new sharp file would judge it to be Rockwell C 55.

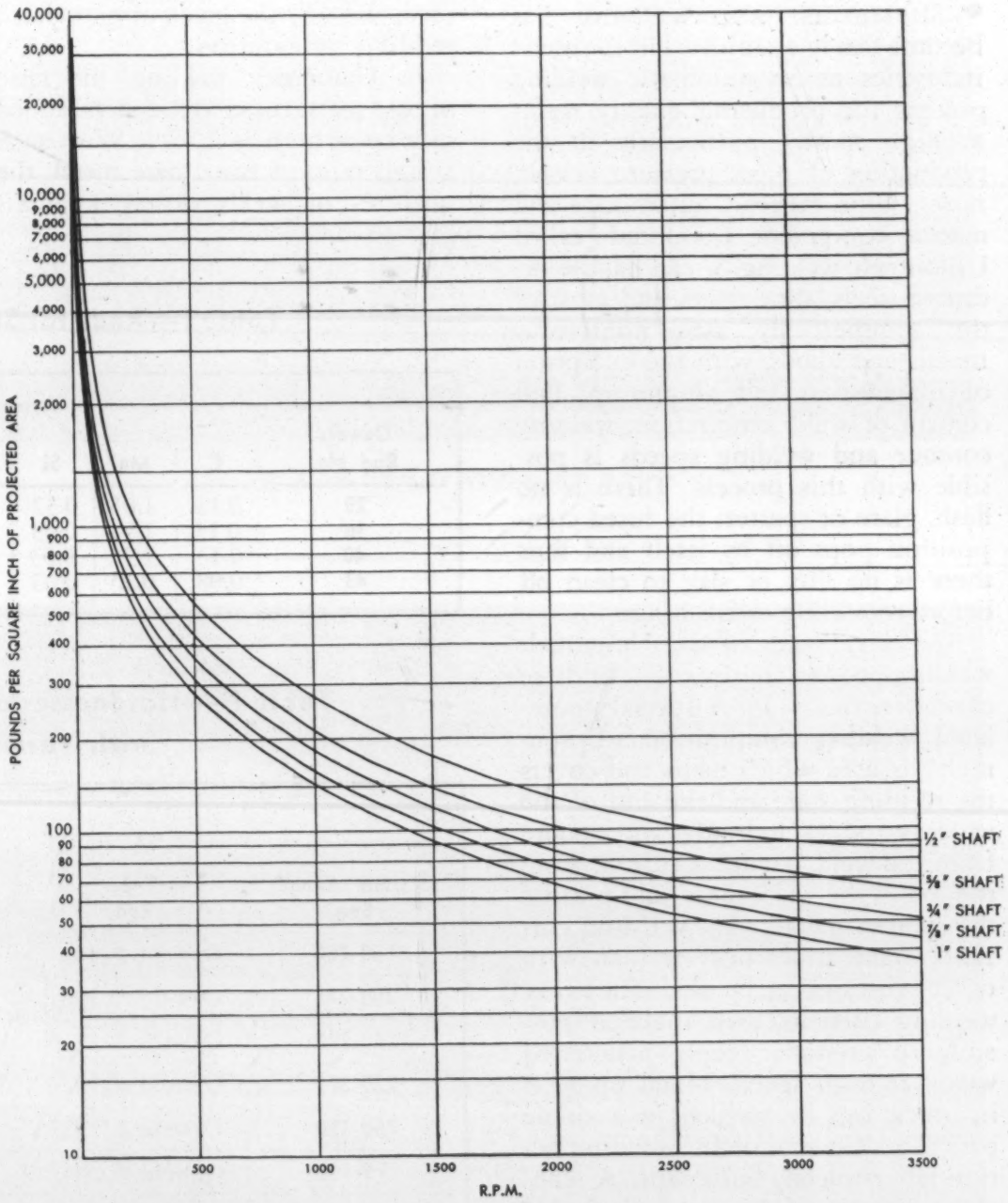
The maximum operating temperatures of the bearings is 225 F. Their corrosion resistance corresponds to that of the best low carbon, copper alloyed steels.

As to actual performance of the bearings, they have been operated continuously for six months with an average consumption of 25% of the original weight of the lubricant. This includes the run-in period, during which 10% to 15% of the loss occurs. When used with a load rating of 35,000 PV, the bearings are lubricated for life. The accompanying chart shows permissible loads for light duty bearings on the basis of 35,000 PV. With many tests having been made on 55,000 to 60,000 PV ratings, it is safe to say that the figures represented on this chart are on the conservative side.

Applications

The pocket feature of these parts lends itself to a wide variety of applications, a number of which are well along in their development. As one example, gears have been produced in which the cavity is not only in the internal diameter but extends into the teeth to provide maximum self-lubrication in parts of this type. These gears, however, are not yet being manufactured on a volume production basis, and details on their lubricating properties and physical characteristics are being withheld until such time as these products can be made generally available to industry.

At the present time, the major volume of production is in pillow block bearings and self-aligning fan and blower bearings. Guide pin bushings, incorporating the wall reservoir cavity, are also being used with definite success, every test proving that there has been negligible wear on either the bushing or the pin and, of most importance, the pin has received adequate lubrication at all times without any attention being required.



Permissible loads for light duty oil well bearings on basis of PV-35,000.

What You Can Do with Submerged Arc Welding

by C. A. Heffernon, Linde Air Products Co.

Unionmelt welding produces high quality welds at high speeds in most of the commercially used ferrous and nonferrous metals, with the exception of magnesium and aluminum.

● SUBMERGED ARC WELDING has become firmly established in the metal industries as an automatic welding process for producing quality welds at high speeds, particularly in the production of pipe, pressure vessels, tanks, ships, railroad, automotive and marine equipment. Commonly called Unionmelt welding, it can handle ordinary steels, alloy steels, and most of the commercially used nonferrous metals and alloys, with the exception of magnesium and aluminum. Full control of weld penetration, welding contour and welding speeds is possible with this process. There is no flash, glare or spatter; the fused composition pops off by itself and thus there is no flux or slag to clean off before rewelding or finishing.

The advantages of the Unionmelt welding process are the result of three characteristics: (1) A special granulated welding composition (Unionmelt) is used which melts and covers the welding zone and the end of the welding rod, excludes the atmosphere from the weld, conducts current from the rod to the work piece, and purifies the molten metal. (2) Welding currents many times heavier than with other processes can be used. The heavy welding currents used make it possible to produce deeply penetrated welds at high speed. Metal up to 3 in. thick can be welded in a single pass. (3) Control of the welding action is completely automatic. A schematic diagram of the process is shown in Fig. 1.

Materials for Welding

The chemical and physical properties of submerged arc welds are determined primarily by three factors. These are: (1) the composition of the base metal, (2) the type of rod used, and (3) the grade of granulated welding composition.

In Unionmelt welding, the ratio of base metal fused to rod metal added may be as high as 2 to 1. With such a high ratio of fused base metal, the qualities of welds closely approximate those of the plate. Furthermore, there is a considerable saving because the amount of deposited metal required is small. Welds made with the correct combination of rod and welding composition have an ultimate strength equal to or often greater than that of the base material itself. The welds possess adequate ductility and impact-resistance, and meet the requirements of the ASME boiler code, American Bureau of Shipping, Lloyds Register of Shipping, and various other codes.

Table I—Rods for Submerged Arc Welding

Oxweld Rod No.	% Composition						To Be Used with Unionmelt Grade
	C	Mn	Si	S	P	Mo	
29	0.13	1.05	0.32	0.03	0.03	—	80, 90 or 50
36	0.13	1.95	0.03	0.03	0.03	—	20, 70, 80, 90
40	0.13	1.95	0.03	0.03	0.03	0.50	20, 70, 80, 90
43	0.08	0.25	0.03	0.03	0.03	—	90 or 50

Table II—Hardnesses of Weld Deposits Obtained with Various Type Rods

Normal Range Bhn	Type Rod	Typical Bhn of Work-Hardened Deposit	Average Hardness of Heat-Treated Deposit Quenched from 1505 F in		
			Air	Oil	Water
150-200	Oxweld # 40	355	—	—	—
200-275	Oxweld # 296	325	—	—	—
210-290	Oxweld # 1730	350	277	490	520
220-275	Oxweld # 1928	330	230	401	490
250-350	Oxweld # 2437	365	375	444	495
275-400	Oxweld # 2842	425	380	430	450
400-550	Oxweld # 4254	525	—	—	—

Table I shows the rods generally used for welding steel by the Unionmelt process. Eleven types of stainless steel rod are available for welding the various grades of stainless steel. Certain of these are also used to surface mild steel to obtain corrosion resistant deposits. For welding nonferrous materials, there are Oxweld No. 19 Cupro Rod, Oxweld No. 26U Everdur Rod, and International Nickel Co. Rods—No. 50 Monel, No. 51 Nickel, and No. 52 Inconel. These are used for welding copper, Everdur, monel, nickel and Inconel, respectively.

In selecting Unionmelt composition, the size range will depend on the current and the type of weld to be made. Although all standard grades of Unionmelt material can be used for welding steel, each one has certain desirable characteristics that recommend it for specific applications. Grade 20 material is generally used for welding steel. It is economical and not particularly sensitive to surface conditions. Grade 50 is recommended for welding nickel and nickel alloys, such as monel and Inconel. It is also used for light-gage, high-speed steel welding. Grade 70 is used for making high-quality welds with improved physical properties. Grade 70, when molten, is least fluid of the standard grades and is used in making girth welds on small diameter sections.

Grade 80 is used to improve the physical properties of the weld further. It is quite sensitive to surface conditions, and the material to be welded must be thoroughly cleaned of rust and scale. This grade is recommended for use on stainless steels, and on Hastelloy alloys and other high-temperature alloys. Grade 90 is used particularly for high-speed welding and also for surface build-up operations. For nonferrous welding, two special grades are available. Grade H is recommended for welding copper and its alloys. Grade K, a special composition, is recommended for welding cupro nickel. For backing the welds, Grade 342 is the highly-refractory composition recommended.

Table II shows the hardness data for surface deposits build-up by Unionmelt welding.

Joint Design and Preparation

The design of the joint and preparation of the plates are two of the most important factors in making a Unionmelt weld. Because the welding creates a very large volume of molten metal which remains fluid for an appreciable period of time, it is neces-

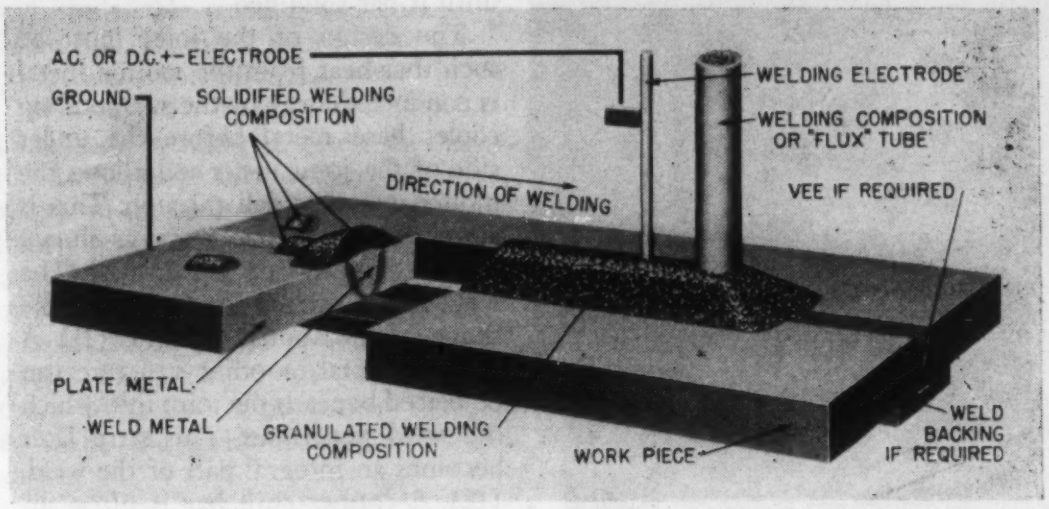


Fig 1—Schematic drawing of the Unionmelt welding process.

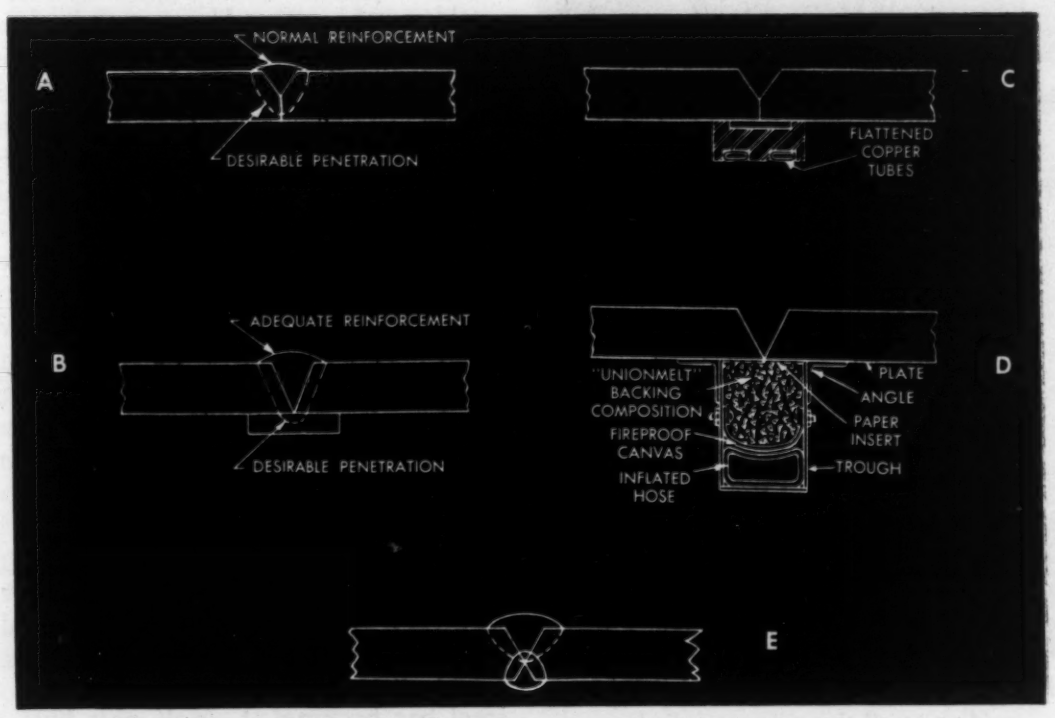


Fig 2—Methods of welding flat butt joints.

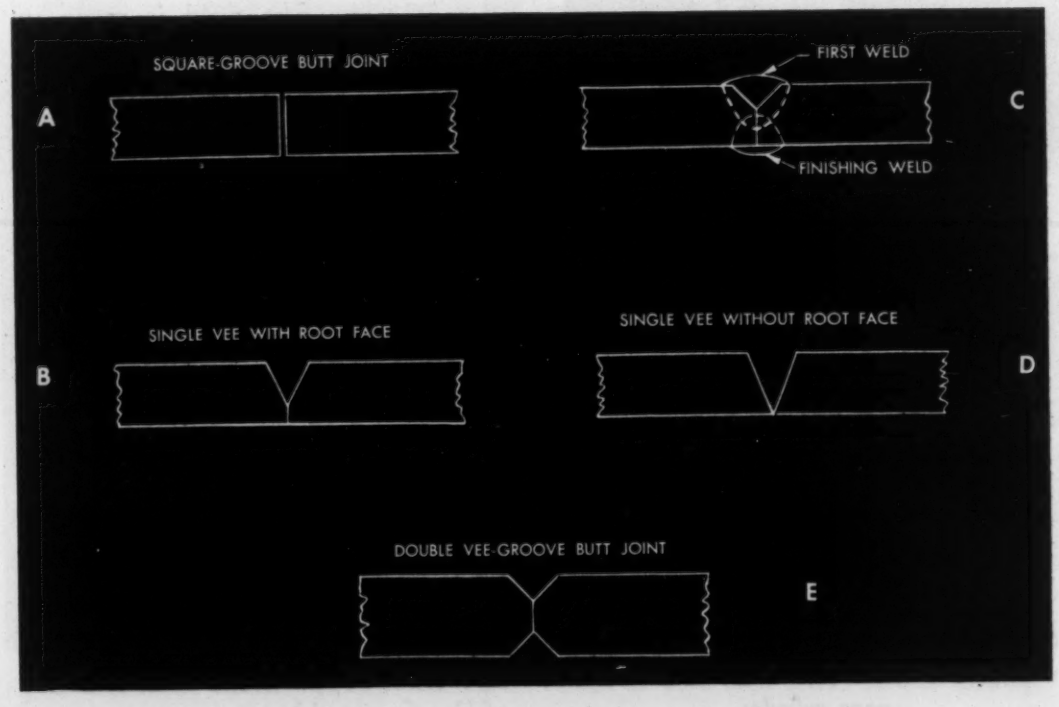


Fig 3—Methods of preparing plate edges for making flat butt joints.

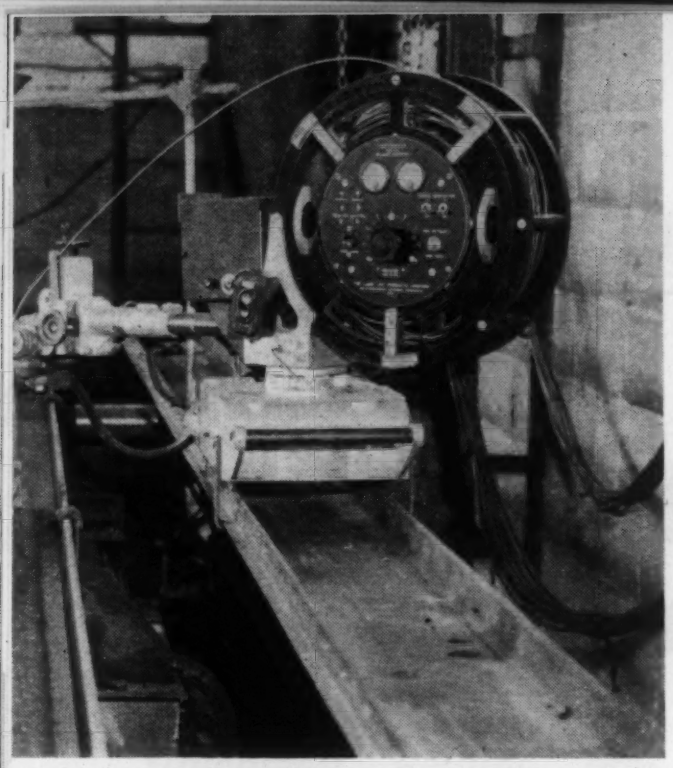


Fig 4—DS machine is mounted on a track above work for welding long straight seams.

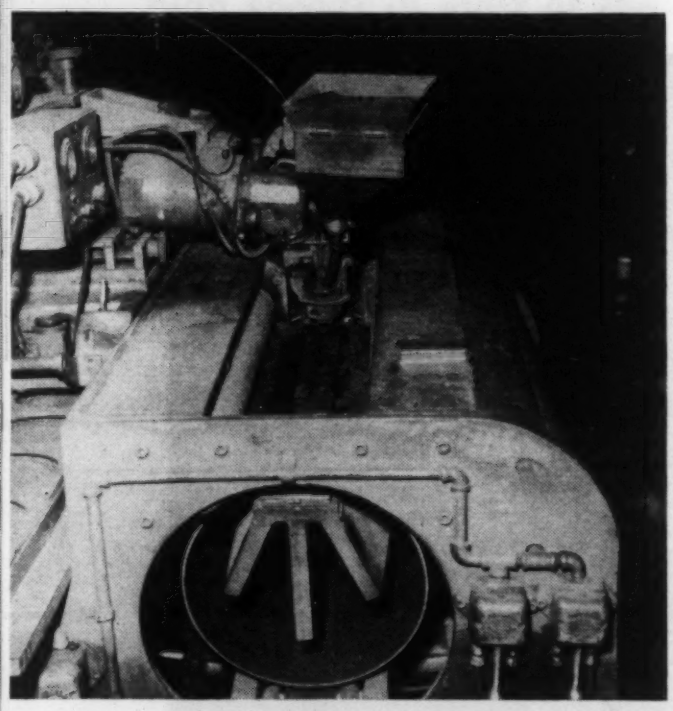


Fig 5—Double-ended horn jig is used for welding small-size propane cylinders.

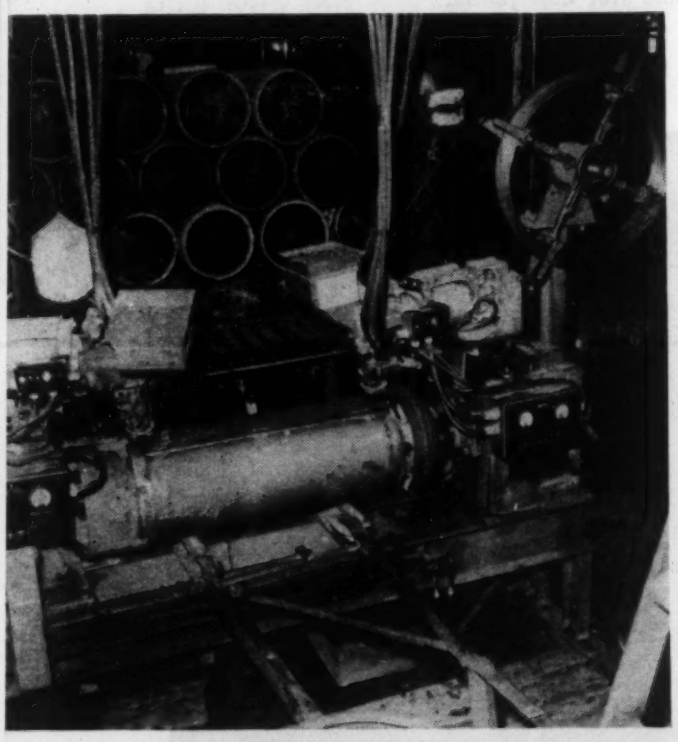


Fig 6—Dual-head insulation is used to make welds simultaneously on both ends of propane cylinder.

sary to support and contain this metal until it has solidified.

The design of the joint must be such that heat from the molten metal is conducted away by the surrounding cooler base metal before the under side of the joint melts and allows the molten metal to fall through. This is accomplished in five ways, as shown in the drawings of Fig 2. (A) The weld metal can be supported by the shape of the abutting plates. (B) A strip of metal or other structure can be placed beneath the joint into which the weld penetrates. This strip later becomes an integral part of the weld. (C) A copper chill bar is often incorporated into the fixture when the joint does not have sufficient mass to provide adequate metal support. (D) Another method of supporting the weld metal is to use Union-melt backing composition beneath the welds. And (E) a small bead of metal can be deposited by manual welding on the reverse side of the joint to provide the necessary support.

In preparing material for welding, the edge preparation will depend on the thickness of the material and the requirements of the joint. Square butt joints similar to Fig 3A are suitable for joining plates up to 5/16 in. thick. If welding is done in two passes, the same square edge preparation can be used for joining material up to 3/4 in. thick. The faces must be brought closely together, and the maximum opening must not be more than 1/32 in. The single vee with root face, as shown in Fig 3B, is generally used for copper or steel bar backing of single pass butt welds in plate above 5/16 in. thick. This joint can also be used for two-pass butt welds where the plate thickness exceeds 5/8 in., as shown in Fig 3C. The first weld is made in the vee side of the joint. The work is then turned over and the finishing weld made on the flat side.

Where Unionmelt backing composition is used, a single vee without root face is commonly used to prepare the plate, as shown in Fig 3D. This type of joint must always have weld backing since the structure is not sufficient to support weld metal at the base. The double-vee butt joint shown in Fig 3E is commonly used for plate thicknesses up to 2 in. It is normally designed with a large root face so that relatively small quantities of welding rod and composition are consumed. The advantage of this type of joint is that no backing is required since the plate structure itself supports the molten metal of the first weld.

Applications

The following examples will show several different kinds of work that can be done with Unionmelt welding equipment, as well as a variety of fixtures and mechanized equipment that can be used to meet the requirements for this process.

Machine on Work or Track—One of the simplest types of installation is where the machine is placed directly on the work and is guided by a wheel riding in the joint ahead of the welding rod. Another widely used method of guiding the welding head is to place the carriage on a track. The track can be placed on the work or supported separately above the work, as shown in Fig 4. In this installation the type DS welding head is used to weld ship channel. The two 4 by 4 angles are welded together to form a channel 8 in. wide and 4 in. deep. The angles are clamped over a trough containing granular backing composition, which permits welds to be made in one pass.

A horn-type jig is useful in high production setups for fabricating cylindrical shapes of sheets and light plate. The horn, or beam of the jig, usually contains a copper backup strip to back the weld. The shape is slipped onto the horn; hydraulic or air clamps hold the edges during welding. The welding head is mounted on a carriage which travels on a track mounted at the side of the fixture. By using a double-ended horn jig, as shown in Fig. 5, the operating factor may be doubled, since one end of the fixture can be unloaded and loaded again while the weld is being made on the other end of the fixture. Here, small size propane cylinders are being welded. Please note that conveyor rolls have been built into this fixture to facilitate loading and unloading at either end.

Stationary Mounting—Another interesting high-production fixture is in use at this same plant After the longitudinal seam has been welded, as shown above, the two ends are welded simultaneously, as shown in Fig 6. The shell is loaded on one side, and the two ends are put in place and clamped hydraulically. As the assembly rotates, the two welding heads join the ends to the shell. The fixture is designed to be loaded from one side and unloaded on the other, thus providing for the best handling of parts and assemblies.

For welding circles either in the vertical, horizontal or some intermediate plane, it is usual to use a sta-

tionary mounting of the welding head and to place the work piece on turning rolls, or a welding positioner.

Continuous Mill—Continuous production of tubular shapes and pipes is easily obtained by using a Unionmelt welding head with a Berkeley mill. The formed shells are fed through the mill. In one application, a 30-in. dia pipe for a natural gas pipeline is welded at 54 in. per min. Two welding heads operate in tandem. The first, using direct current, establishes the weld and the second, using alternating current, supplies metal to fill the vee. Even faster speeds of welding are being successfully obtained using alternating current on two heads in tandem, with a three-phase connection.

Surfacing and Clad Metals—Besides using the Unionmelt process to join separate pieces of metal, the process is also used to build up worn areas or to impart special properties to the surface layer. Fig 7 shows how Unionmelt welding was used for rebuilding the bore of a ram hammer. Manual welding in such a confined space would be practically impossible, but by using an extension nozzle on the automatic welding head, as shown in this photograph, weld metal can be easily deposited in such places. The smooth, even beads were laid down along the length of the bore. The deposited metal is fused with the base metal and there are no flux or slag inclusions. The bore was easily machined to the original dimensions.

The conventional submerged melt welding techniques thus far described produce welds having deep penetration into the base plate material and are deposited at high rates of travel speed. For applications requiring cladding with dissimilar metals, such as stainless steel or nonferrous materials, or building up of local areas on relatively thin base metal, minimum penetration and dilution of the deposit by melted parent plate metal are desired. A recent development involving the use of multiple electrodes in series now makes possible production of welds at normal travel speeds with unusually low penetration and dilution values ranging from 1 to 10% base metal. By appropriate positioning of the welding rods, close control over the depth of penetration and weld shape is obtained. In addition, a marked increase in the rate of rod deposition and a lower rate of fused melt consumption are possible. This new multiple electrode technique offers significant advantages in the field of automatic cladding and surfacing with high-alloy and hardenable welding rod composition and for applications requiring rapid deposition of metal.

Mechanized Shape Welding—Unionmelt welding is often mechanized for production welding of any shape in a horizontal or approximately horizontal plane. This is easily done by mounting the welding head on a shape-following carriage. A templet, made to the proper outline, guides the tracing head and moves the welding unit at the proper speed to make the weld of the required shape.

Manually Guided Unionmelt Welding—One of the latest developments in submerged melt welding is the production of a machine with a flexible, hand-guided nozzle. This was designed to combine the best features of Unionmelt welding with those of manual arc welding. The welding rod and composition is fed through a flexible hose about 20 ft long. This gives the operator considerable freedom of manipulation and enables him to weld odd shapes, or to make welds in confined spaces where a welding head could not be introduced and where automatic guiding could not be economically used. This illustration, Fig 9, shows the flexible welder located at the hub of the work area, with some 14 fixtures arranged in a circle. The operator uses the one machine to weld at successive stations while a helper loads and unloads the fixtures. Thus, a highly efficient operating cycle is obtained.

Fig 7—By using an extension nozzle, welds can be made in a small opening. Rebuilding 5-in. dia bore of ram hammer.

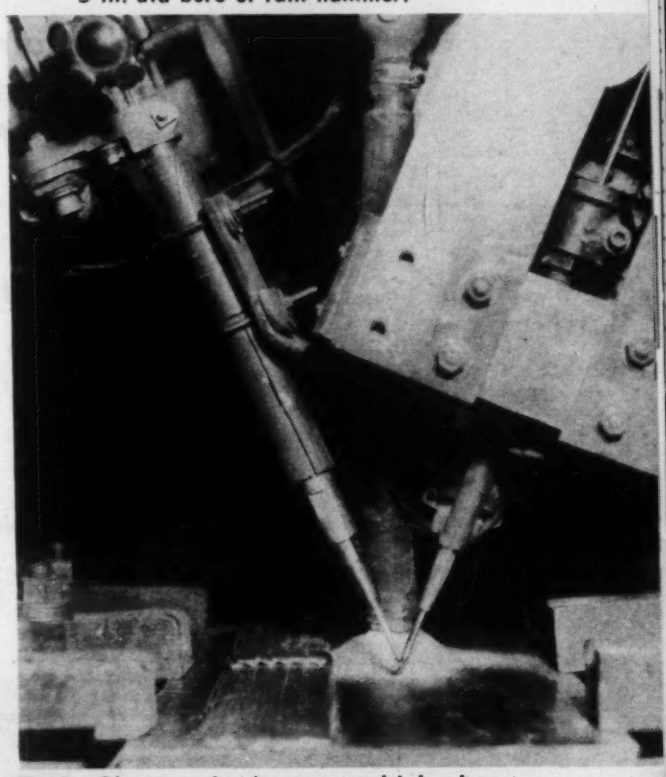


Fig 8—Close-up showing new multiple electrode technique for surfacing.

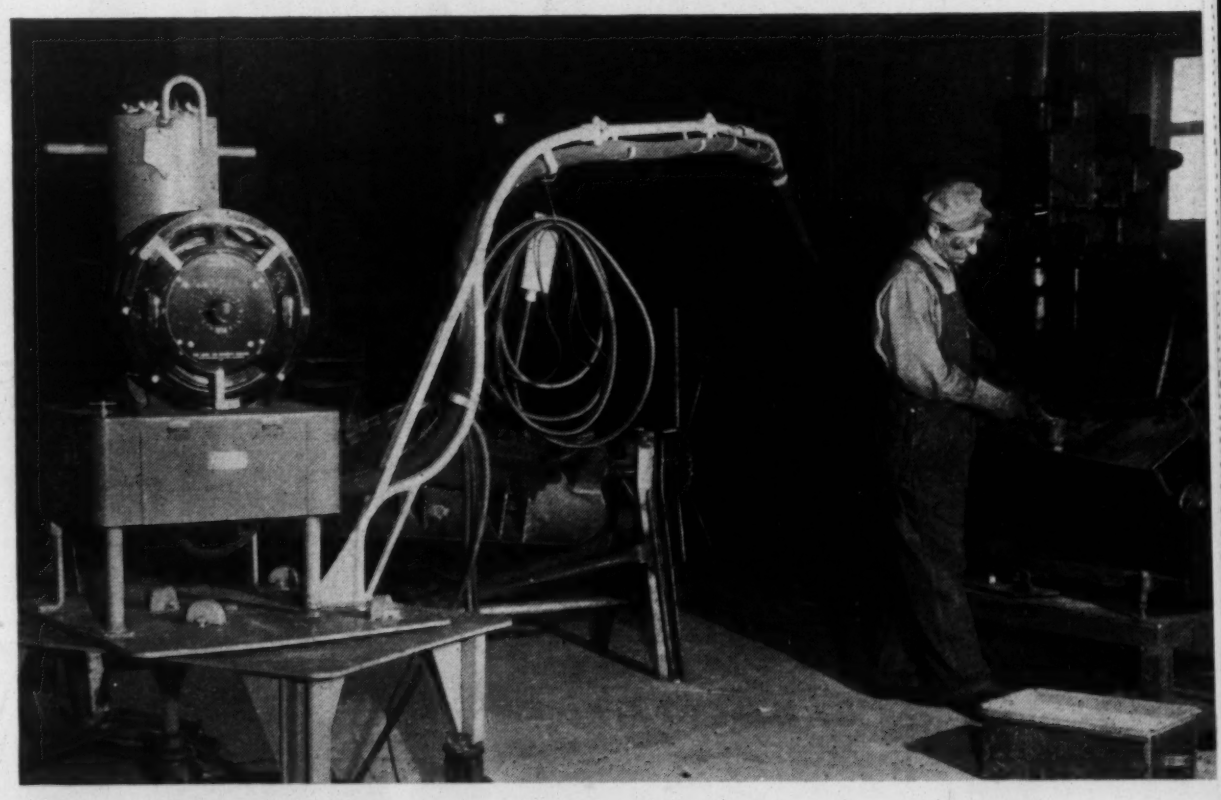


Fig 9—Automatic flexible welding machine at center of work area serves several welding stations.

Automatic Spinning of Stainless Steel in Production

While stainless is rather difficult to spin, the process shows definite advantages over press forming on parts made of light gage stock.

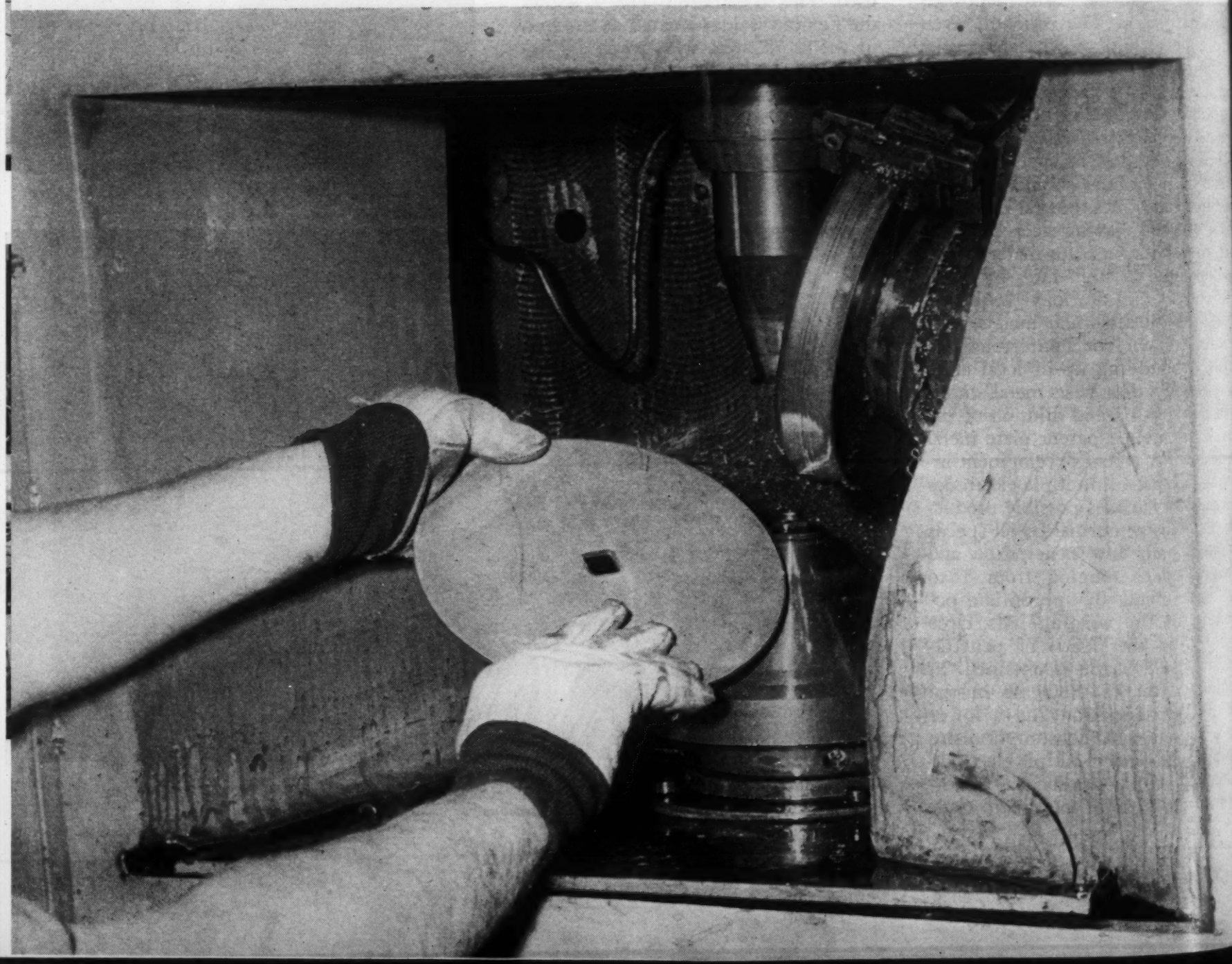
by L. W. COURT,

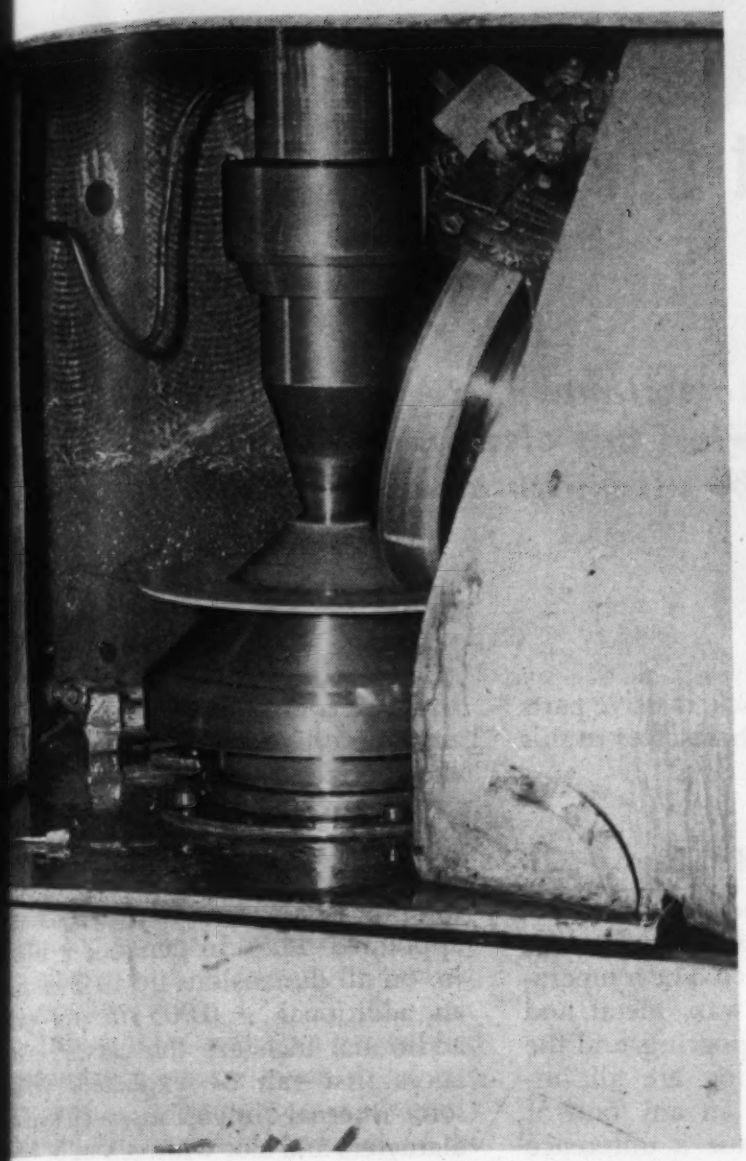
Works Engineer, Richmond Works, International Harvester Co.

• CERTAIN METAL FORMS, symme
rically curved about a longitudin
axis, offer a choice of forming met
ods. When the part is to be made
light-gage stock, spinning will som
times show advantages over pre
forming because of the complete
nearly complete utilization of t
metal in the blank and the simplici
of the tooling. However, the skille
hand labor required has always been
disadvantage; also, stainless steel h
been somewhat more difficult to sp
than most other metals because of t
rapidity with which it work-harden

Production of several parts f
cream separators by Internation
Harvester Co. required the formi
of stainless steel on a production bas
Some of these parts having variatio
on the shape of a truncated cone we
suitable for forming by spinning, a
International Harvester Co.'s eng
neers set about producing machin
that would make spinning a high-pr
duction, mechanized process. A dra
on the conical form of the crea

Stainless steel circle blank is placed in spinning machine.





The blank being formed by the spinning process. Form is about half complete in this picture.

Piece being removed after spinning operation. Later, press operations give final form.

eparator bowl shell would have been ifficult to accomplish wnile holding all thickness to close tolerances, and he shape of the bowl shell would ave required several steps to produce y any means other than spinning (*i.e.* drawing). Stainless steel of the 02 type was the material specified.

The bowl shell is made in four different sizes for the four sizes of McCormick separators, and the blanks used are disks of 8 to 10⅞ in. in dia. A square hole is punched in the center of each for positioning and for holding the work during spinning. For this piece, the spinning machine consists of a revolving face plate on which the conical spinning mandrel or die is placed over a vertical work spindle. Mandrels are interchangeable. The mandrels themselves are made of hardened and nitrided tool steel so as to resist deformation under pressure of the spinning roll. A square driver projects a short distance above the center of the spinning mandrel, and the blank is held in place during the spinning operation by this driver, which fits into the square hole in the center of the blank.

A carbide-faced spinning roll is brought against the work near the center of the blank, and feeds downward and outward to form the cone. The outside diameter of the cone is the same as the outside diameter of the blank, the cone being formed by thinning the metal. The included angle in the cone is 90 deg. The machine is capable of spinning pieces with an included angle of as little as 50 deg, or as much as 110 deg.

In subsequent steps of the operation some of the outside diameter is trimmed off and the bowl shell is drawn to final shape in a three-station die, pierced in the center and formed at the neck. To facilitate handling and coordinate the operations, the spinning machine and two presses are built into a production unit, and production rates on the three machines are synchronized to produce one bowl a minute.

The formed bowl shells are later machined at both ends, and are polished inside and out. This completes the machine work on the bowls.

During the spinning process the work piece revolves at 700 rpm. Faster speeds tend to roughen the work. The spinning roll is carbide-faced to eliminate galling, and is cooled by circulation of water inside the roll. A light coat of oil on the surface of the stainless steel also helps the spinning. Metal in the blank is 0.140 in. thick, and this is thinned slightly by the spinning operation. Stock as heavy as $\frac{3}{16}$ in. has been spun successfully on the machine.

Before the spinning operation was introduced into the procedure for making the bowls, they were drawn by the usual press operations. Two anneals were required to reduce work-hardening of the metal during the series of draws, and a cleaning operation was necessary after each anneal. The oxide film formed was difficult to remove. In addition, the draws themselves were difficult. Spinning has eliminated the anneals and cleaning operations, as the work moves from the spinning machine immediately into the presses built into the proces-ing unit.

The Plus and Minus of Steel Precision Investment Castings

by A. C. WILLIAMS,
Sales Engineer, Spaulding Works, Crucible Steel Co. of America

Important guide posts help to indicate when this often misapplied process should be used with steel and high temperature alloys.

● INVESTMENT CASTING of steel and high temperature alloys is complimentary to other fabrication methods and should only be used where its inherent advantages can be capitalized on. Unsophisticated application can make a white elephant out of an extremely valuable process. Before the lost wax method of precision casting is specified for a part, the problem should be studied from four separate angles.

Size of the Casting

Although the majority of lost wax castings weigh less than 4 oz, there are many applications up to 1 lb, and, in a few instances, castings weighing as much as 25 lb have been produced successfully. Until improvements are made in technique and equipment, however, pieces will in general be confined to weights under 1 lb.

Investment castings up to 10 in. in length and 5 to 6 in. wide are considered practical. The process is at its best with relatively thin sections—about ¼ in. max. Thick, massive parts do not usually lend themselves to this type of casting.

Dimensions and Tolerances

More than 20 independent variables in the casting process affect the dimensions of the piece. The temperatures of the mold, wax, metal and flask, the method of pouring, and the speed of the operation are all important. A variation in any one of these factors will cause a difference in size from piece to piece.

Other variables are encountered in constructing the mold. Machining tolerances in the metal patterns and molds and the allowances required for sliding parts and removable inserts will all vary. These determine the mean measurement of each dimension.

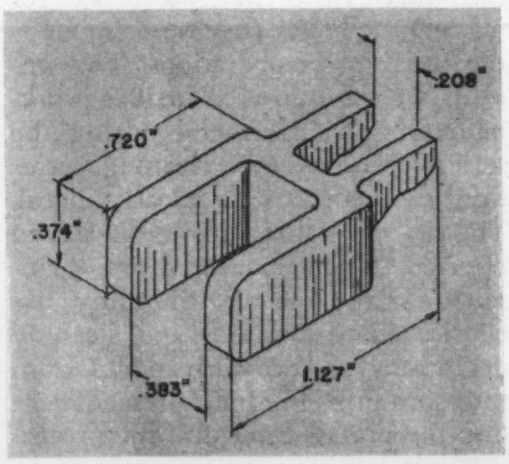
It is necessary to tool carefully for a casting in order to bring each mean dimension as close as possible to the nominal values shown on the drawing; then the processing variables must be controlled to keep the variations on each mean dimension within the specified casting tolerances.

Fantastic claims of extremely close tolerances, down to 0.0005 in. in some cases, have given the investment casting process a bad name with some disappointed users. In general, ± 0.005 in. on all dimensions up to 1 in. and an additional ± 0.005 in. for each additional inch are the closest tolerances that can be expected. While some internal dimensions, such as hole diameters and slot widths, can be held to small limits, they should not be so specified unless it is absolutely necessary.

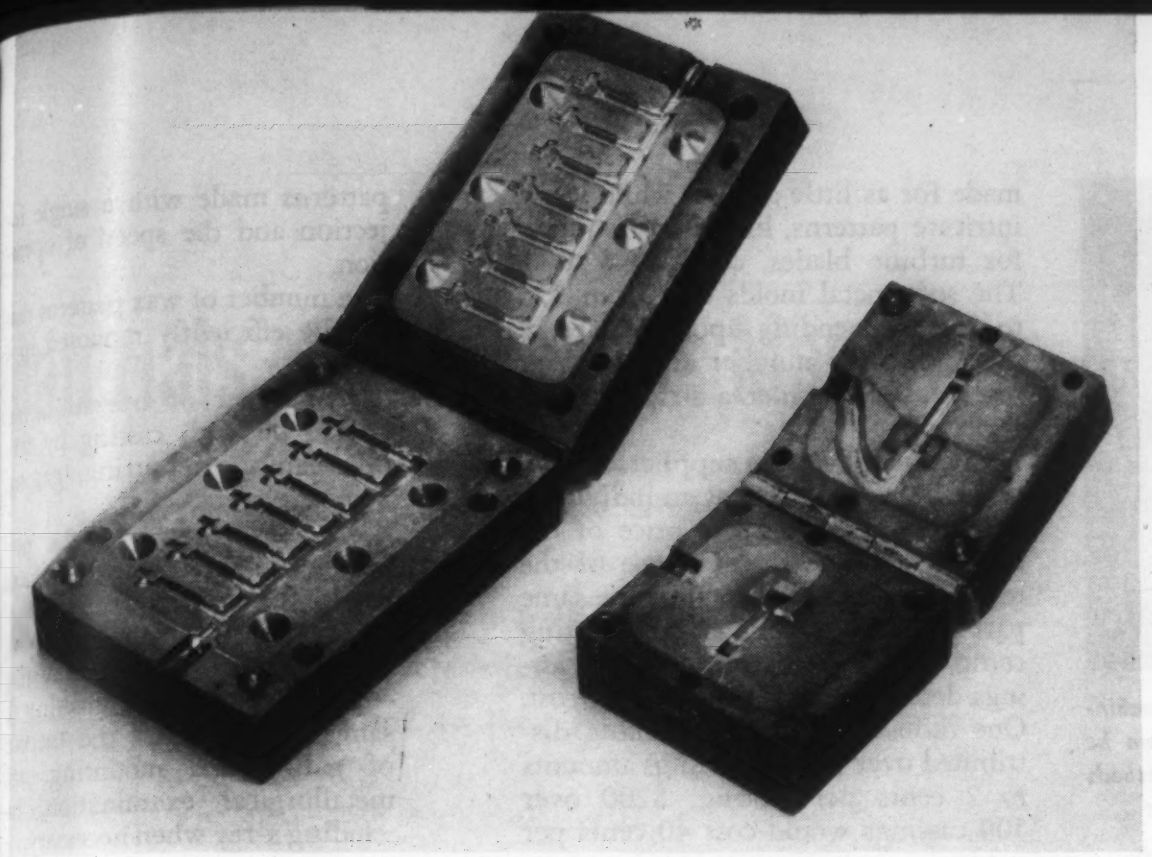
There must be a clear understanding between the maker and user as to how the castings will be gaged and what the critical dimensions are. The direction in which the mold is parted and the location of the gate are important factors affecting dimensional control.

The chances of hitting the correct size on the first run vary with the intricacy and irregularity of the part,

Measurements from 1000 castings show the percentage falling within each set of tolerance limits on each dimension. Internal dimensions can be held closer than external lengths.



Tolerance, In.	Nominal Dimensions				
	0.720-In. Length, %	1.127-In. Length, %	0.374-In. Thickness, %	0.208-In. Slot Width, %	0.383-In. Slot Width, %
Plus or minus:					
0.001	46.7				
0.002	70.9	31.0	47.6	73.6	83.5
0.003	86.0	49.4	68.0	96.0	100.0
0.004	93.0	74.4	82.0	100.0	—
0.005	97.3	88.7	93.4	—	—
0.006	99.2	97.2	98.0	—	—
0.010	100.0	100.0	100.0	—	—
		—	—	—	—



Casting costs are lower with a multiple-cavity wax injection mold than with the single cavity mold at right.

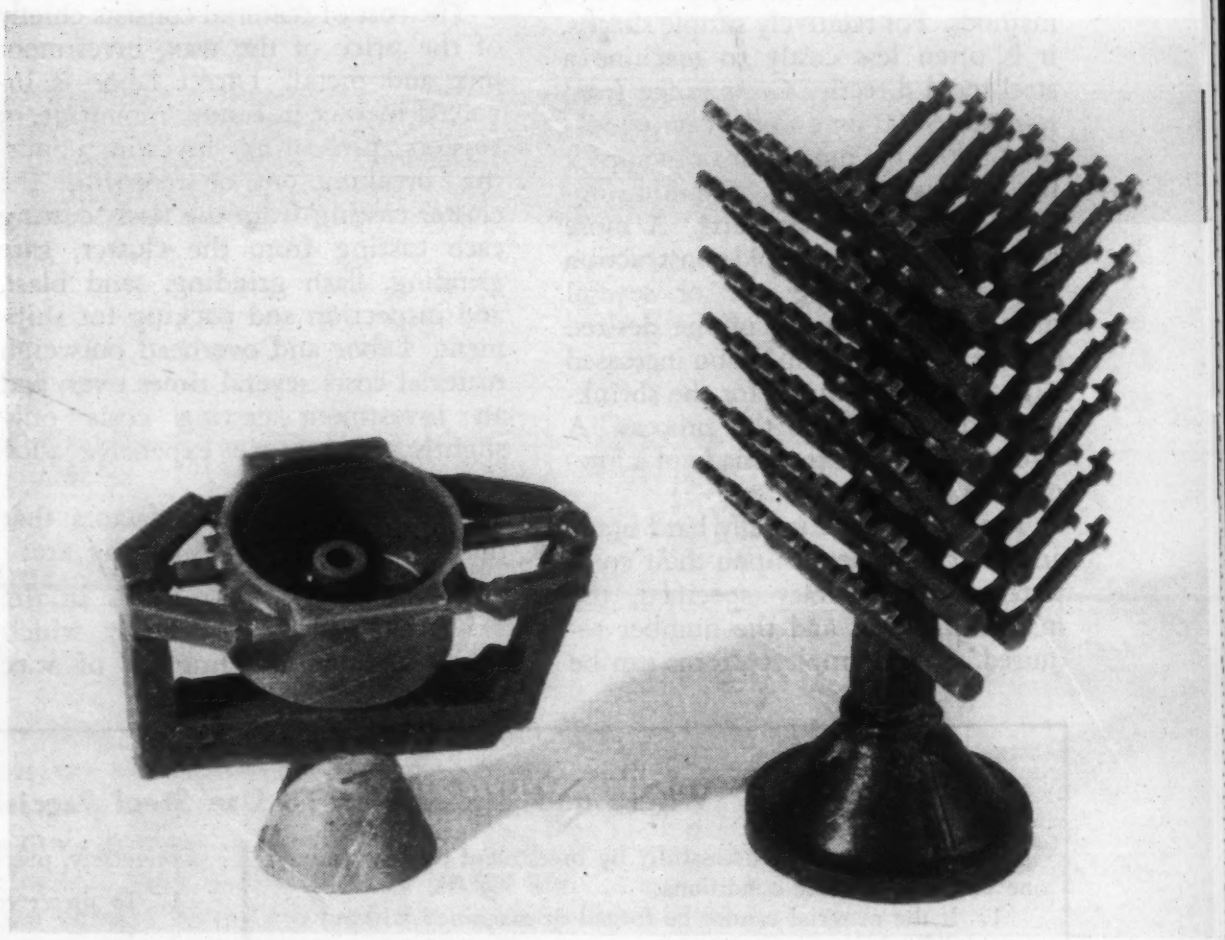
and sufficient time should be allowed before going into volume production. It is important for purchasing men to get any precision casting item on a new program out of Engineering as early as possible and permit adequate time for proper tooling, production of samples and alteration of tooling, if necessary.

After sample castings are approved and instructions are given to go into production, it then becomes necessary to set up rigid controls over all of the variables in the process. This control is needed to obtain uniform castings within specified dimensional tolerances.

The table with Fig 1, taken from actual measurements on 1000 castings, shows the percentage of pieces falling within various tolerances on five dimensions. Tolerances of $\pm$ 0.005 in. are required for external dimensions if the number of rejects is to be held to 2 to 3% for each external dimension. In lowering the margin allowed from $\pm$ 0.005 in. to $\pm$ 0.003 in., the yield would be decreased to approximately 65% and the casting price would increase accordingly, to make up for a large rejection of castings plus the higher cost of inspection. To obtain the highest casting efficiency with the lowest price, all unusually close tolerances must be avoided.

Metallurgical Quality

By using rigid metallurgical controls, investment castings in steel and high temperature alloys can be made to high quality standards. By proper gating, routine, chemical analyses, raw material control, together with x-ray, Zyglo and visual inspections, it is possible to produce clean metal, free of internal and surface defects.



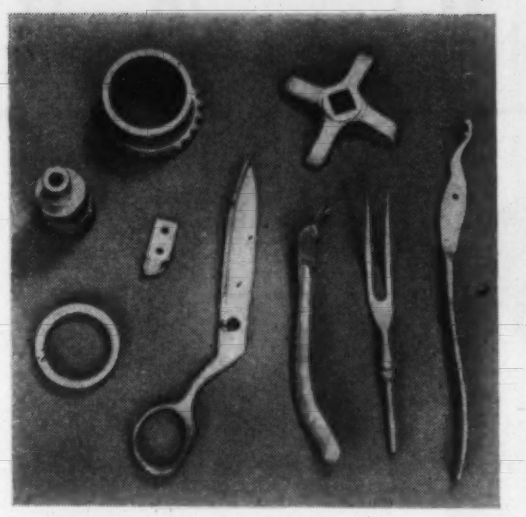
The single wax pattern at the left requires several gates to ensure a sound casting, while the cluster at the right joins a number of patterns to a central sprue by runners.

Centrifugal casting, pressure casting, vacuum pouring and other special techniques are often used to ensure sound, well defined castings. Pouring the metal into flasks that have been heated to 1500 F or more permits delayed solidification and avoids gas entrapment and porosity. This is the most important factor contributing to sound castings.

The tensile strength, yield strength, response to heat treating cycles and hardnesses of investment castings are practically identical to the corresponding properties of wrought materials of similar composition. Although elongation, reduction of area and impact strength of castings are generally lower than the values obtained in the direction of the grain in rolling, hammering or forging, they are often superior to the transverse or across-the-grain properties of wrought materials. Except where the directional values of wrought materials have an important bearing in their application, castings can be safely substituted.

Cost

The most important item is the cost of tooling. The mold for forming



A number of parts that, in ordinary machinable or forgeable grades of steel, can be made more economically by other methods than precision investment castings.

wax patterns can be made by two methods. For relatively simple shapes, it is often less costly to machine a steel mold directly. Costs range from less than $100 for a single-cavity mold to $1,000 or more for a complex multiple-cavity mold containing inserts and slide-fitting parts. A more common method of mold construction consists of making one or several metal master patterns of the desired casting, with each dimension increased slightly to compensate for the shrinkages encountered in the process. A two-piece mold is then made in a low-melting alloy.

The patterns are usually hard brass, and the cost depends upon their complexity, the accuracy specified, the machining time, and the number required. Small, simple patterns can be made for as little as $25, while large, intricate patterns, like those required for turbine blades, can cost $2,000. The soft metal molds cost from $75 to $300, depending upon the size of the molds, the number and shape of inserts, and whether a stripper plate is necessary.

Investment casting suppliers usually quote the tooling cost as an individual item, separate from the price of the casting, and the maintenance of the tooling for future orders for the same part is usually borne by the casting company. The total number of castings determines the unit tooling cost. One thousand dollars in tooling distributed over 50,000 castings amounts to 2 cents per casting; $200 over 500 castings would cost 40 cents per casting.

The cost of material consists chiefly of the price of the wax, investment mix and metal. Direct labor is involved in wax injection, mounting in clusters, precoating, investing, pouring, breaking out or removing the cluster casting from the flask, cutting each casting from the cluster, gate grinding, flash grinding, sand blast, and inspection and packing for shipment. Labor and overhead outweigh material costs several times over, and an investment casting costs only slightly more in an expensive alloy than in carbon steel.

Five other important factors that influence the cost of a casting are:

1. Number of impressions in the mold and its complexity, which determine the number of wax patterns made with a single injection and the speed of operation.
2. The number of wax patterns that can be efficiently mounted in a flask.
3. The number of operations required on each casting by way of cleaning, deburring, gaging, inspection, etc.
4. The casting yield or the percentage of acceptable castings of the total number made.
5. The fixed cost in the processing of each new investment casting —engineering costs, making of samples, laying out the method of gating and mounting, and metallurgical examination, including x-ray when necessary.

These factors determine the price of a casting. They contain the answers to the questions commonly asked: Why are some castings so expensive while others are so inexpensive? How can castings be made at a lower price? Why is there such a quantity differential in pricing?

From what has been said it is evident that designers, development engineers, detailers and production men should have a thorough working knowledge of the process, as a good investment casting is conceived on the drafting board, not derived from a part designed to be made by some other process. Precision casting engineers should be consulted early in a development program to assist in laying out designs without casting hazards.

Where and Where Not To Use Steel Precision Castings

A part can be made successfully by investment casting under one or more of these conditions:

1. If the material cannot be forged or machined without difficulty.
2. When expensive machining operations would be required for fabrication.
3. When expensive tooling, special milling cutters, form tools and forging dies can be avoided by an investment casting.
4. Where assembly costs are eliminated by combining two or more parts into a single casting.
5. Where a necessary up-grading in material makes an inexpensive operation, such as stamping or drop forging, impossible.
6. Where the quantities required are adequate to absorb investment casting tooling and initial order engineering costs.
7. If quantities are insufficient to absorb expensive forging, drop forging and stamping dies or the cost of tooling for special shape rolled bars.
8. When it is necessary to increase productive capacity without increasing machine tools or labor force.

Conversely, precision investment castings are not competitive:

1. In direct competition with a stamping.
2. In direct competition with a drop forging, except small quantities.
3. In direct competition with a screw machine part.
4. Where the major machining operations on a part can be performed in a turret lathe.
5. Where the principal machining operation can be done on a broach or a fast milling operation.
6. Where the tolerances required are too close for investment castings—it is usually as easy to machine a much cheaper sand casting.

Materials & Methods Manual

This is another in a series of comprehensive articles on engineering materials and their processing. Each is complete in itself. These special sections provide the reader with useful data on characteristics of materials or fabricated parts and on their processing and application

70

Compression Molded Plastic Parts

by Kenneth Rose, Western Editor, Materials & Methods

Compression molding, and the closely related transfer molding process, are widely used for producing dense, strong and smoothly finished parts of thermosetting plastics. They are also used to a minor extent with thermoplastic resins. High quality molded pieces are dependent upon correct formulation of the molding material, proper mold design, and careful control of the variables in the molding process. This manual, therefore, discusses all these factors, along with the properties and applications of compression molded plastics.

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Introduction

One of the features of that group of nonmetallic materials known as the plastics is the property of plasticity. Although the ability to soften under heat and to be formed (forged) in this softened condition is one of the valuable properties of metals, relatively few of the groups of nonmetallics possess it. Glass and rubber can be hot-formed, or can be heated farther to an essentially liquid state and cast into molds, but most other nonmetallics, such as wood, asbestos and the ceramics, can be shaped only by such means as machining or by mixing with a binder and pressing cold between dies.

Plasticity of the plastics, considered in terms of moldability, makes it possible to shape a piece to essentially finished form directly from the raw material, and in one operation. As molding of plastics is done at temperatures only a few hundred degrees above room temperature, pieces can be molded to rather close tolerances, and with surface finish that needs no additional work except trimming flash to be suitable for most purposes. Molding of plastics is, therefore, a high-production mechanized process, and as such fits into modern schemes of manufacturing.

Of the molding processes, one of the first developed, the simplest, and the most used is compression molding. Compression molding consists of placing the charge of molding resin into the mold cavity, by hand or with the aid of a loading device, closing the heated mold sections, and holding until the material has been squeezed to all parts of the cavity and has hardened. In another process, closely related to compression molding both as to the molding materials used and the mechanics of the process, the charge is placed in a chamber outside the mold cavity, and when fused is transferred to the cavity by a plunger. This is called plunger molding, or transfer molding.

The nature of the processes and the character of the plastics materials makes compression molding, and also transfer molding, almost wholly a process for the thermosetting resins. The thermosetting resins harden, or cure, by chemical reaction, and this is carried to completion by heat. Application of heat to the resin while in the mold cavity first causes it to liquefy, then, as the cure advances, to harden to an infusible material. The thermoplastics, on the other hand, are softened by heating and harden again upon cooling, as do the metals. Compression molding of the thermosets permits the loading of the charge for a single complete cavity into the cavity, the closing of the dies and application of heat, and withdrawing of the formed piece as soon as cure has caused it to harden. The process is poorly suited to the molding of the thermoplastics, as the mold must be cooled after each piece has been formed to permit the material to harden again. Likewise the method most used for molding the thermoplastics, injection molding, is unsuited for work with the thermosets, as the material would tend to cure and harden in the heating chamber, before it could be injected into the mold cavity.

In spite of the disadvantages of compression molding for the thermoplastics, it is used to some extent for these materials because it lessens the danger of incomplete filling of large molds when the piece to be molded has thin sections, and helps to eliminate visible flow lines and similar faults in clear materials. Such use is unimportant in comparison to the quantity of thermosetting materials formed by compression, but represents a means of producing a quality product difficult to obtain otherwise.

Transfer molding, which represents a method of approaching injection molding technique for the thermosetting resins, must meet the handicap of loss of the material remaining in the heating chamber and in the sprue, as this resin hardens and is unusable. It possesses certain advantages, to be discussed later, that give it a place in the molding of thermosets.

Compression molding is so well established as a forming method for plastics that in spite of the gains in production of the thermoplastics, there are more compression molding presses in operation than any other kind. More phenolics are molded by compression molding than are formed by all other methods combined.

In general, compression molding is done at rather high pressures, perhaps 1000 to 5000 psi. However, some work is done at pressures as low as 200 psi, and lower pressures and shorter curing cycles are the rule with the newer formulations of resins now being offered for high production. Properly molded pieces are dense, with smooth surface finish and good strength. Properties in the finished piece are dependent upon both proper formulation of the molding material and proper adjustment of temperature, pressure, and other factors during the molding process. Mold design, temperature of the mold, temperature of the material, and length of time during which pressure is applied are some of the process factors that affect the quality of the finished piece.

The general properties of the various types of molding materials have already been discussed in previous MATERIALS & METHODS manuals (see Thermosetting Plastics, Manual No. 49, May 1949, and The Thermoplastics, Manual No. 57, Mar. 1950). Therefore, it is recommended that the reader refer to these two manuals for further details on the subject.

Composition of Molding Materials

The formulation of molding resins and the molding operation do not fall within the province of the materials selection function, but the materials engineer should know something about the ingredients and how each affects the properties of the finished piece. The molding powder as made up by the resin manufacturer is formulated to meet the molder's specifications, and can be molded as received.

Formulating can be done only by someone with complete knowledge of the requirements of the finished part and the molding conditions under which it is to be produced. For example, if a piece is to be molded of a phenolic so as to reduce cost to a minimum, it might be decided to increase the filler content to cut material cost. This has the effect of lowering the moldability (flow) of the material, however, and if the shape of the piece is rather complicated, or requires flow through thin sections, or is to be made in a multiple-cavity mold in which sprues have been made rather small to reduce the loss of material, it may be necessary to add a small quantity of plasticizer to improve the flow.

Other factors, such as the degree of cure of the molding resin, the amount of preheating given the preforms, the amount of working to which the molding resin is subjected before molding, the surface finish requirements of the molded piece, and the dimensional stability requirements, may enter into the selection of materials making up the formulation.

Resins

The resin is the most important ingredient in the molding material. It is made by the chemical reaction of phenol and formaldehyde, in the case of the phenol-formaldehyde resins; urea and formaldehyde for the urea-formaldehydes, and so on. As has been explained in earlier manuals, the base chemicals are reacted to produce a resin, but the process is stopped short of conversion to the insoluble, infusible state that it reaches finally as a molded plastics material.

This final conversion is called cure, and the resin is said to be in an incompletely cured state. It is still fusible, and it is therefore possible to heat it and to mold the fused material. Cure advances rapidly with application of heat. The rapidity with which the resin is converted to infusible polymer can be controlled to some extent by the degree to which the cure is advanced in the manufacture of the resin, and this, stated as *flow*, is an important variable in determining moldability. Resins that develop considerable fluidity in the mold when fused are said to have soft flow, while those that set up rather quickly are designated as of stiff flow.

Other things being equal, a resin of stiff flow is desirable for molding small or simple objects such as buttons. The molding material has ample fluidity to fill out the cavities for such simple shapes, and sets up quickly to give high production. A softer material would tend to be squeezed out of the mold as flash and would cure so slowly as to lengthen the molding cycle. When molding parts with thin sections or complicated shapes, however, greater fluidity in the resin is necessary to avoid hardening before the mold is completely filled.

Fillers

The most important added material is the filler. Fillers can be organic or inorganic, powdered or fibrous. They may be classified as follows:

Organic fillers

1. Powdered. Wood flour, walnut shell flour, cocoanut shell flour, peanut shell flour, almond shell flour, apricot pit flour, etc.
2. Fibrous. Chopped fabric, cotton flock, cotton cord, alpha cellulose, sisal.

Inorganic fillers

1. Powdered. Asbestos floats, powdered mica, diatomaceous earth, clay, graphite, lead oxide, etc.
2. Fibrous or leaved. Asbestos fiber, asbestos fabric, glass fibers, exfoliated mica, etc.

In general, the powdered organic fillers provide good moldability and good surface appearance; fibrous fillers, organic and inorganic, provide good impact resistance; inorganic fillers, fibrous or powdered, provide thermal resistance, and good resistance to moisture, with good electrical properties.

Wood flour is the cheapest material to add, and is by far the most widely used. In addition to serving as an inert filler that reduces the cost of the molding material, wood flour can be used to affect properties in several desirable ways. Moldability is generally improved, though the resin will have a stiffer flow. Mold shrinkage is reduced, thus improving the dimensional tolerances it is possible to maintain. Longtime dimensional stability is improved also. Water resistance is lowered, and with it electrical properties under moist conditions. Mechanical strength will usually be improved, but high percentages of filler will cause it to be lowered. Thermal resistance is lowered.

Wood flour is the filler for general purpose phenolics, and is used with melamine resins also. Walnut shell flour is especially useful when good surface finish is necessary in the molded piece. It is usually used together with wood flour, the percentage of walnut shell flour being only what is required to obtain the quality of surface finish needed. The shell flour seems to fill the voids adjacent to the mold surface, reducing the tendency to "dog skin" and "orange peel" effect sometimes found in molded surfaces with the general purpose materials. Flours of other nut shells are sometimes used for the same purpose, but are not as well established.

The fillers given above are suitable for use with the phenolics. Melamine resins are produced as wood flour filled molding materials, and mineral fillers are used in melamines intended for electrical applications. Ground asbestos is the filler used, and some asbestos fiber may be included to increase impact strength.

Fillers of organic fiber are used with the phenolics, and most of these are suitable for use with the melamines also. Chopped cotton cord greatly increases the impact strength of molded plastics, some of the high-impact phenolics showing impact strength as much as 20 times that of the general purpose materials. Unfortunately, difficulty in molding increases about as rapidly as impact strength. Water absorption increases also. Chopped cotton fabric and cotton flock are used as filler with both the phenolics and the melamines to produce strong molded pieces. Sisal has been used to some extent as filler with the phenolic resins. Alpha cellulose, a highly purified wood pulp, is the standard filler with the ureas, as it has been found that these resins possess poor molding properties with other reinforcing materials. Both melamines and phenolics are compatible with alpha cellulose also, and this filler is used when good impact resistance must be combined with good color and good surface finish.

Asbestos powder is an important filler for phenolics intended for heat-resistant parts. Its use in mineral-filled melamines has already been mentioned. Pieces for electrical applications also make use of the asebstos filler, though powdered mica is superior in dielectric strength. Diatomaceous earth and clay are other fillers used in heat-resistant grades of phenolics. Graphite has been used as an additive to phenolics intended for use as bearings, as it imparts an antifriction quality to the material. The mineral fillers increase the stiffness of flow of the resin, and may abrade the molds somewhat. Lead oxide may be included in the formulation of a molding material for shielding against x-radiation.

Asbestos fiber, as such or as woven fabric, is an important filler when the molded piece must possess both heat resistance and mechanical strength. Powdered asbestos with a proportion of fiber (added or residual) is used for the same purpose, and a liberal percentage of chopped cotton cord may be added to asbestos fiber filler without seriously impairing the heat resistance of the molded plastics material for most purposes. Exfoliated mica has been used for some heat-resistant applications. Chopped glass fiber has been limited in the case of the phenolics, but recently it has been found possible to mold the polyester resins with glass fiber as a filler, using compression molding techniques.

Housings, such as this one for adding machines, are a typical application of compression moldings. (Courtesy Durez Plastics & Chemicals, Inc.)

Pigments

A pigment or other coloring matter is an ingredient in most plastics formulations. Even where a material is to be used in a "natural" color a pigment is usually added so that all pieces, and all batches, will be uniform in color. Pigments are used especially where an opaque color is required to hide the filler. Dyes, either alcohol- or oil-soluble, are used to impart more brilliant colors.

With the phenolics, which are brown in color, it is necessary to add a white pigment if a light shade is desired. A dye can be used in connection with the opaque white pigment to develop most colors. The dyes used are soluble in the resin, and can produce brilliant, warm colors in the darker shades. Pigments are usually used in the darker colors in addition to the dye when the filler must be masked.

A secondary effect of pigments is in control of electrical conduction. Pigments that are slightly conductive are desirable in such pieces as gears, where a static charge tends to build up during running. Carbon blacks and some iron oxide pigments may be used for this purpose. Their

use as opacifiers must be avoided when high dielectric strength is a requirement, however.

Ureas and melamines usually contain some white pigment when a cellulose filler is used, but the natural color of the resins is light enough to permit production of nearly all shades without the necessity of masking the color of the resin itself. As the uncured resins are quite soluble in water, the dye may be made up with a small amount of water and the solution mixed into the prepared white powder. Even light pastel shades can be produced. The dye can be incorporated in the resin during manufacture also.

Other Ingredients

Other ingredients sometimes used to control molding conditions include *accelerators* and *plasticizers*. Accelerators will speed the curing reaction, permitting the resin to set up quickly in the mold, while plasticizers may be used to improve the flow of a formulation that otherwise would be too stiff to mold easily. Accelerators tend to lower the strength of the molded material, and must be used with the required properties of the piece in mind.

Other materials are used occasionally in a molding resin formulation, to obtain a special effect, or to reduce costs. One of these, which might be included under fillers, is plastics material trimmed from molded pieces, ground to powder, and mixed into the molding resin. This ground flash has the same composition as the material fed into the molds, but as poylmerization has been completed it does not enter into the curing reaction. It does not contribute to strength, but does provide a filler that is non-hygroscopic, does not lower heat resistance, does not increase the nonresin content of the molding material, reduces mold shrinkage, and is low in cost.

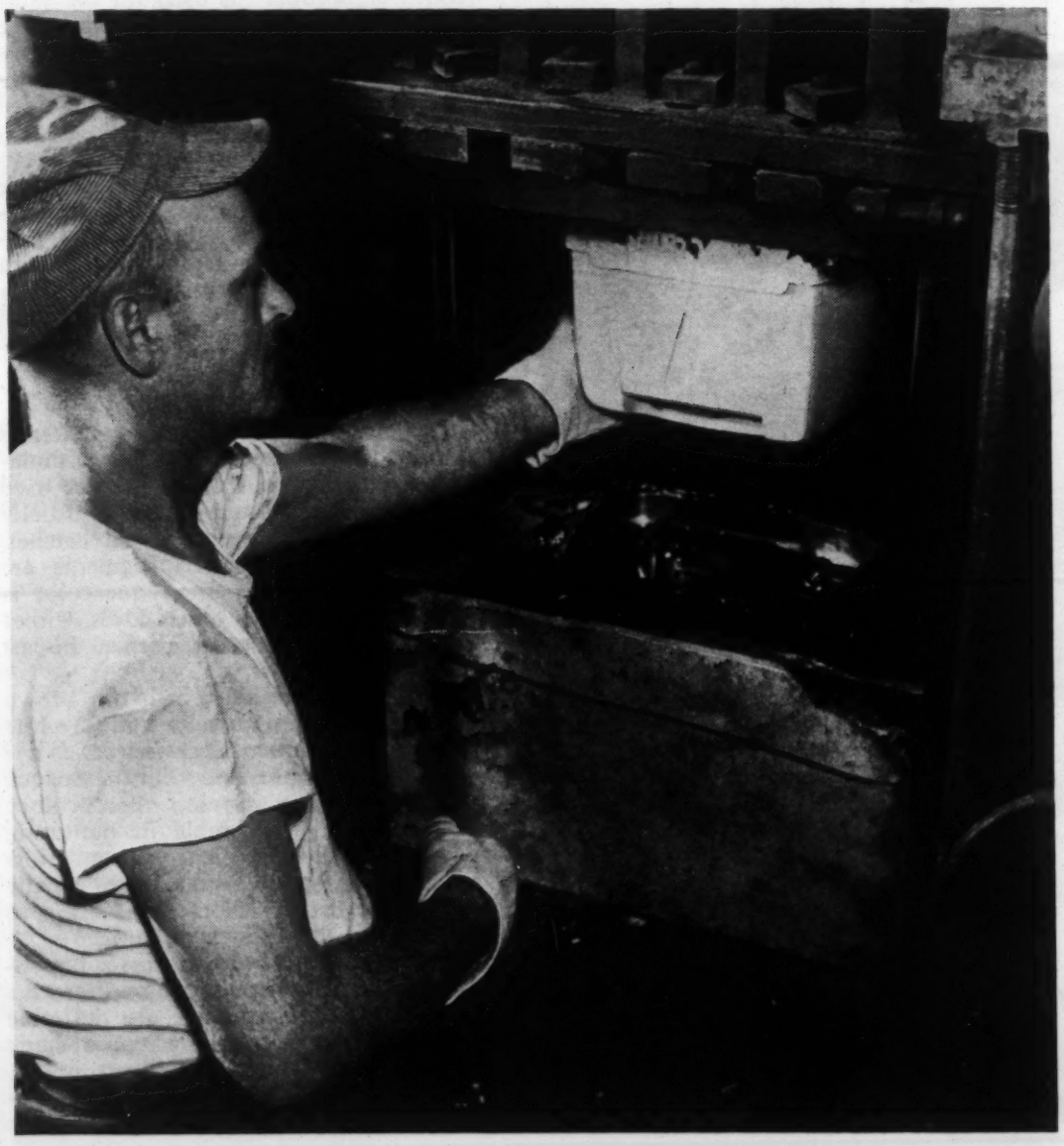
How Compression Moldings Are Produced

Preparing the Materials for Molding

The resin manufacturer usually supplies a granular molding material or molding powder formulated to the molder's specifications. Preparation of this material for molding at the plant of the molder consists of preforming and preheating, where used. In some cases the molding material is first dried to drive off any moisture it may have picked up, and then preformed or preheated. A relatively new process, dry mixing, permits the molder to make up his own color formulations in his plant as needed, but this process is still used mostly for thermoplastic resins.

Dry mixing consists of thorough mixing of dry dye and molding material in drum mixers. It permits the molder to make up relatively small batches of molding material in colors. He can keep down his inventories considerably by making up only the amount needed for each run. The molding material is purchased in natural color, so that it can be made up to any shade in whatever quantities are needed.

Molding radio cabinets of urea-formaldehyde plastic at American Insulator Co. (Courtesy Plaskon Div.)

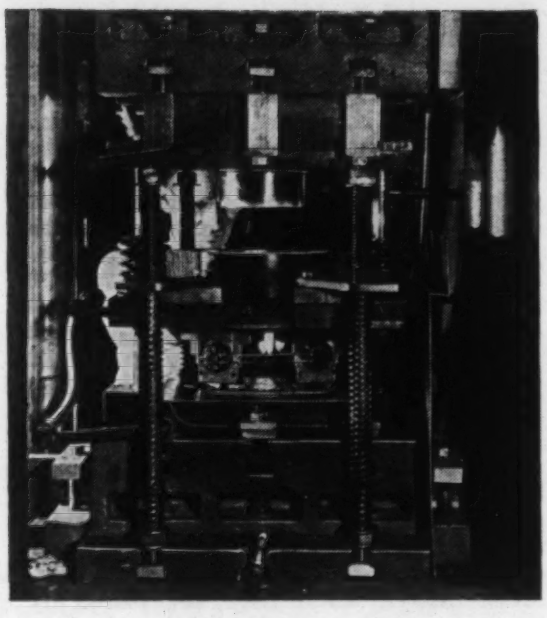


The molding powder or granular molding material will frequently benefit from a drying operation. This has as its purpose the removal of traces of moisture remaining in the resin, or picked up during storage while awaiting molding. Blistering or rough surface in the molded piece may result from this small amount of moisture in the molding material, though cellulosic filled materials may be improved in moldability by the presence of small quantities of moisture. A second operation, which may be combined with the drying in many cases, is the preheating of the molding powder or preform, to reduce the amount of heat that must be transmitted through the mold during the molding operation. Both of these operations involving heat input to the resin can be accomplished by infrared heating, by high-frequency heating, or by use of conventional ovens, often steam-heated.

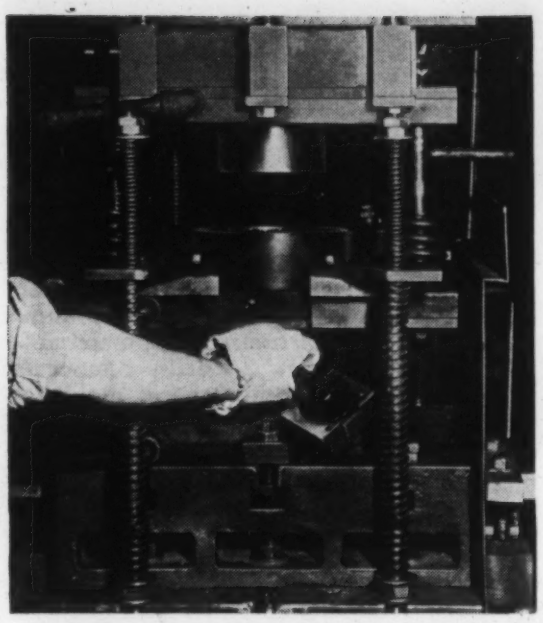
Preheating has as its object the speeding of the cure reaction by applying heat to the resin before it enters the mold. The immediate effect is to increase the flow of the material. This benefit can be realized in any or all of several different ways: (1) the increase in size of the piece capable of being molded in a given press and mold; (2) increase in speed of molding in a given piece; (3) decrease in press pressure required to close the mold.

The amount of preheating is determined by (1) the length of time heat is applied, (2) the temperature reached, and (3) the amount of energy, as heat, put into the material. As the chemical reaction that results finally in the resin being converted to an infusible material is carried forward during the application of heat, it is necessary that the time the material is subjected to heat, and the time from preheating to molding, be closely controlled. Excessive preheating may result in precuring of part of the material, especially if the resin is made up of a large preform. Preheating temperatures of the phenolics may be of the order of 275 to 325 F for from 150 to 50 sec by dielectric heating, though the temperature, time, and heat input must be determined with regard to each other, and to the requirements of the specific molding job. The use of steam heat may make slower heating advisable and 30 min at 220 F might

Molding powder is made into preformed pellets and preheated by this induction unit.



Preheated pellets of the correct amount are dropped into press pot (center) of this transfer molding press and are flowed into mold under 80 to 85 tons pressure at 250 F.



When curing is complete, the press opens and the molded part and fixture are carefully removed from the mold cavity for subsequent finishing operations. (Courtesy Durez Plastics and Chemicals, Inc.)

Steps in compression molding of telephone handset—

be a suitable combination.

A requirement for all molding in which the material is enclosed in the mold cavity or a closed auxiliary is that the amount of molding material so enclosed must be accurately measured. For both compression and transfer molding, if the amount of molding material enclosed is insufficient to fill out the cavity, the piece will be spongy in structure or incomplete in form. If too much material is enclosed, the excess may be squeezed out of the mold as flash or will represent lost material as cull. The method of measuring the amount of material will depend upon the form in which it is to be used, whether a charge of granular material, or a tabletted charge, called a preform.

Preforming, in which the charge is compacted into a biscuit, possesses several advantages in that the charge is easier to handle, somewhat easier to measure, and permits the use of such devices as loading boards. Tabletting presses can be hand operated for small pieces, or can be automatic in operation for high production. One of the big advantages of preforming is that it simplifies preheating, and so permits faster press operation.

A process sometimes added to the preparation of the molding material to speed the molding procedure is preconditioning. This is auxiliary to preheating, and consists of running the preheated preform through a calender roll or screw press to work the material to higher fluidity. By preheating to a temperature and for a time determined as optimum, and then calendering before feeding the molding material to the presses, pieces of larger size or more difficult form can be made in presses smaller than would be possible otherwise.

The processes mentioned above as part of the preparation of molding material are open to considerable variation in order. In the preparation of a urea molding powder, for example, the white powder might be dried, ground, wetted with a water solution of a dye, redried, reground, and then measured into the press. Preforming and preheating usually precede transfer molding, as the increased flow is required to press out the material without waiting for softening in the mold itself. Preconditioning after preheating is a relatively new step, and finds its biggest advantage in the molding of very large pieces, such as the 80-lb shots for television cabinets. Preforming is usually necessary when molds of many cavities are used, as in the making of buttons. It is advantageous in compression molding when the molding material must be reduced in bulk to permit closing of the mold after placing the charge.

Types of Molds

Molds for compression molding are of three types:

1. Hand molds. These are the simplest, least expensive to produce, and are usually the smallest. The mold consists of two or more parts, fitted together by hand after the charge of molding material has been placed inside the molding cavity. The complete mold is then lifted onto the lower platen of the press, and pressure is applied. When cure is completed the mold is lifted from the press, opened, and the piece is removed. Because the mold must be moved to and from the press, usually by hand, for each cycle, the molds are usually small and light. Hand molds are also used when the shape of the piece is such that a complex mold is required.

2. Semiautomatic molds. The mold sections are attached to the top and bottom platens of the press, and are opened and closed by press operation. The knockout pins or other device to remove the molded piece from the mold cavity also operates automatically during the press cycle. The mold is loaded manually. The press cycle is manually controlled, also. Molds of this type are used when the size or shape of the piece requires a large mold, or when the mold is made with multiple cavities and is of large size. Deep molds that fill with difficulty in hand molding are usually made as semiautomatic types. These are the general-purpose molds, used for all kinds of materials, thermosetting and thermoplastic. Heat may be applied by steam coils in the mold, or by electric heating elements.

3. Fully automatic molds. These are specially designed for use on automatic presses, and provide for automatic loading of the mold, automatic knockout, and heating of the mold by means of internal steam coils or electric elements. The mold can incorporate cooling coils also, if needed for temperature regulation. Automatic operations make placing of inserts, a hand operation, difficult, and pieces requiring metal inserts are usually made in semiautomatic or hand molds. Fibrous-filled materials used for high-impact plastics may flow into the mold with difficulty during the loading, and are not generally considered suitable for automatic operations. They cause more difficulty in filling out the mold also.

For transfer molding, molds are of the following types:

1. Loose-plate molds. These are the simplest types, and are manually loaded and placed. A loose plate rides above the mold cavity, and forms the top of the transfer chamber. This loose plate may sometimes be incorporated into the press as a floating platen, and the transfer chamber may be located in this platen to simplify mold design. The molds are then designed to utilize this stock transfer chamber. Loose-plate molds are especially useful when the piece to be molded is to contain one or more long inserts, as the inserts can be positioned in the plate in many cases, simplifying loading of the mold. The molded piece, loose plate, and hardened material remaining in the transfer chamber are all ejected together. If two plates are used, one can be loaded while the other is in use in the mold.

2. Integral molds. These are probably the most used type of transfer molds. The transfer chamber and its plunger are a part of the mold, permitting design of the entire mold as a unit for most efficient operation. The transfer chamber can be gated directly into the mold cavity, or can feed into it through a sprue. The chamber can be located above or below

the cavity. Integral molds can be designed for either manual operation or semiautomatic use.

3. Auxiliary plunger molds. Using the main ram for clamping and an auxiliary plunger for forcing the resin into the mold cavity, auxiliary plunger molds can achieve high production. These molds can be fitted to certain types of injection molding machines, making the operation fully automatic. The injection machine must have both a main ram for clamping and an injection ram for transporting material. The heating chamber is usually removed from the press when this type of mold is used.

Speed of operation of auxiliary plunger molds is improved by preheating the molding resin. Transfer presses must have an auxiliary ram to use molds of this type. The molds can be designed for use on angle presses, where the auxiliary ram operates at an angle to the main ram, usually right angles. The amount of material lost in sprue and cull is reduced to a minimum in auxiliary plunger molds.

In addition to the above, molds may be classified in other ways as single- or multiple-cavity, according to the number of pieces to be made in each shot; as positive, semipositive, landed positive, or flash molds, according to the location of the cavity, molding well, and certain other design features. In addition to these basic types, there are many special features built into molds to increase production or improve the quality of the product. Molds can be designed with a stripper plate to knock out the molded piece, with cam activation for sections of the mold, with special sectioning or splitting of the mold to permit removing pieces of unusual shape, with dual plungers or cavities to permit loading or cleaning one section while a similar section is on the press.

Molding Process

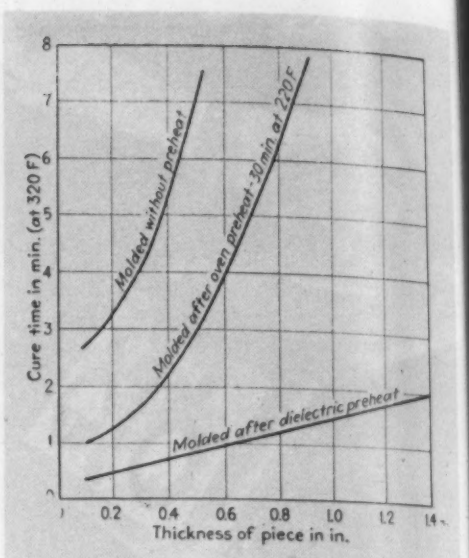
The molding process itself consists of charging the mold, closing the mold, curing the resin, opening the mold and removing the piece, and cooling the molded piece. In transfer molding the material in the sprue and heating chamber is removed with the molded piece.

Molds for both compression and transfer molding are held at molding temperature throughout the cycle when molding thermosets, but must be cooled before removal of thermoplastics. The charge, whether in the form of granular molding material or a preform, is placed in the cavity when the mold has been heated to a predetermined temperature in the case of the automatic processes, while with hand molds the mold will have cooled somewhat during removal from the press. The hand molds are heated by conduction from the press platens.

The charge is preheated for high-production work, and the hot molding material can be run into the cavity or cavities as a powder, or loaded from a loading board as tablets or in powder form. The loading board, a fixture having cavities arranged to correspond to the position of those in the mold itself, permits loading of all the cavities in a multiple-cavity mold by one motion of a slide that opens the bottoms of all the board cavities. Metal inserts, where used, are placed by hand or, occasionally, by loading devices. As soon as the charge has been placed in the hot mold, the mold is closed. The closing begins slowly, under low pressure, until the plug comes into contact with the charge. High pressure is then applied, forcing the heated resin into all parts of the cavity. In some cases, especially when molding ureas, or when molding heavy pieces in phenolics, it is advisable to open the mold for an instant to permit escape of gases liberated by the beginning of the cure reaction. This is called "breathing the mold."

During the cure period the reaction that converts the resin into an infusible, insoluble material progresses to practical completion. The time required depends upon the extent to which cure was advanced during manufacture and preparation of the resin for molding, and the temperature of the mold. The phenolics require a mold temperature of about 325 F, the exact temperature depending upon the formulation of the resin, and especially of the type of filler used, as well as upon the time at temperature. For the melamines and ureas, the mold temperature is about 300 F. Temperature must be closely controlled when molding the ureas, as these materials are especially susceptible to burning. Alkyd molding compound requires a mold temperature of about 300 F also.

The phenolics are capable of wider mold temperature variation than any other of the thermosets. Mold temperatures as high as 450 F have been used in combination with high preheats for short periods and cure cycles of less than 10 sec. Where the shape of the piece is such that a long slow cure is desired, the temperature may be reduced to 275 F or less. Some idea of the relationship between mold temperature and time of cure is given by the accompanying cure curves for the various types of phenolics.



Effect of preheating phenolic molding compounds.

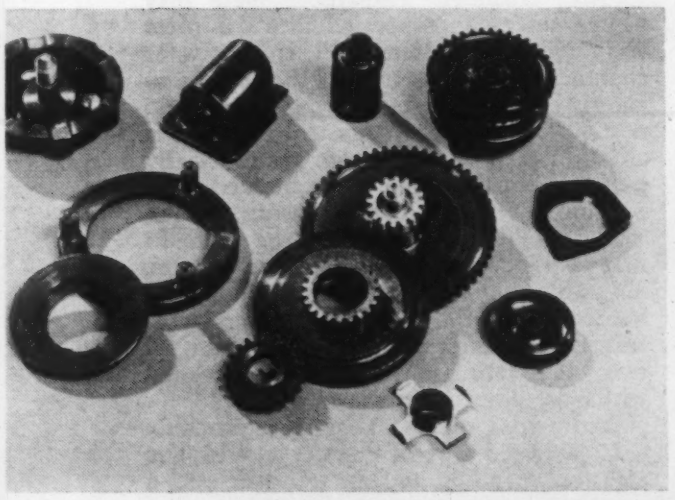
With the ureas, mold temperature may vary from about 275 to 325 F, depending upon the time held at temperature, but cure temperature only slightly in excess of the optimum may result in overcure. Overcured pieces appear dull and opaque. The latitude in cure time is greater, especially at lower temperatures. Attempts to shorten cure time by increasing mold temperature increase the danger of overcure.

The melamines are molded at temperatures much the same as those for the ureas, but the material remains in the fusible condition for a longer time than do the ureas. Melamines may be preheated closer to the mold temperature without danger of precuring, and the latitude in mold conditions is wider.

The mineral-filled alkyd molding compound announced a few years ago cures very quickly, and cure cycles may be a matter of a few seconds at the mold temperatures recommended, 300 to 310 F. Many small parts are made with cure time of 5 to 10 sec, and even pieces with rather thick sections may be cured in 2 min. This requires a fast-acting press, and small pneumatic presses are used for making small pieces. Mold pressures are low, of the order of 500 to 900 psi, so that the quick-acting air-operated presses have ample capacity.

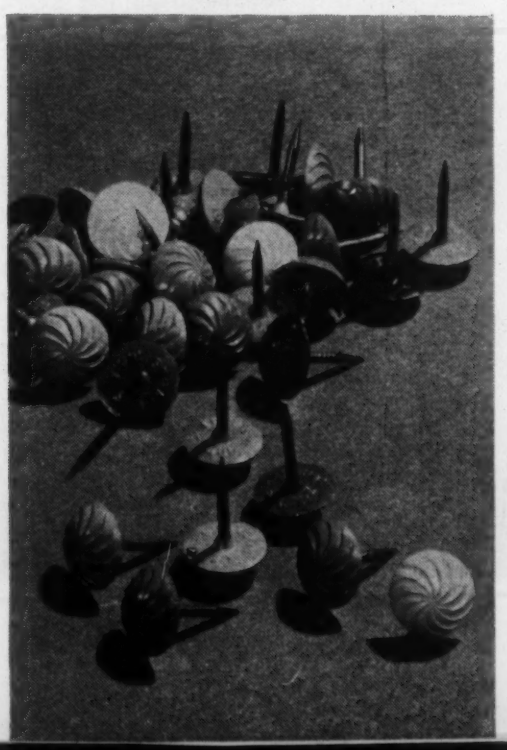
Methyl methacrylates are frequently compression molded when they are to be produced as clear pieces. Colorless or tinted molding powders can also be used. The powder is placed in the hot mold and the heat-softened material is forced into all parts of the cavity, with the mold remaining at a temperature that insures against partial chilling of the acrylic. The mold is then cooled to harden the plastics material, and the piece removed from the mold.

The cellulosics can be compression molded, except the nitrate, but the process



Some of the more than two dozen molded phenolic components produced by Molded Products, Inc. for the Ryan aerial camera. (Courtesy Durez Plastics & Chemicals, Inc.)

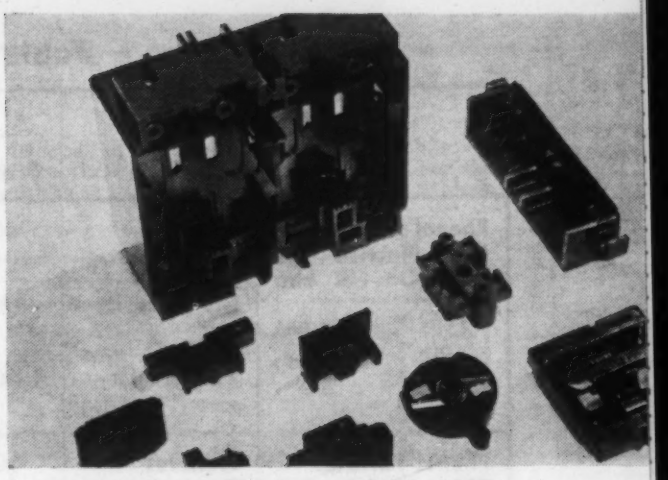
Upholstery tacks produced by compression molding. (Courtesy B. F. Goodrich Chemical Co.)



has fewer advantages than with the acrylics. Polystyrenes are likewise capable of compression molding, and the method is sometimes used to produce pieces larger than could be made on available injection machines. Nylon molding material can also be processed in compression presses.

Transfer molding procedure differs from compression molding in that the molding material, almost invariably preheated, is placed in a hot chamber in the mold and is forced into the closed cavity by a plunger. Because the mold cavity is closed, there is ordinarily no flash, and finishing costs are reduced. Materials are charged into the mold at temperatures closer to molding temperature, and the process is usually faster than compression molding, but wastes a certain amount of material in sprue and cull.

An advantage of compression over injection molding is the fact that the hot mold keeps the material highly fluid until the cavity is completely filled. In this way the danger of flow lines showing in the finished piece is minimized. In injection molding the heat-softened material is forced into a cold mold, and striations may appear if part of the charge is chilled too quickly.



A group of compression molded plastic parts for electric fuse and switch boxes. (Courtesy The Borden Co.)

Properties of Compression Molded Plastics

While the materials engineer need not have expert knowledge of the formulating and processing of plastics materials, it is necessary that he understand the properties conferred upon the finished plastics material by its components, and how the composition may be changed to accentuate or minimize one or more of these properties. It has already been pointed out that price, the molding equipment available and the properties required in the finished piece must all be considered in formulating the resin. The resin manufacturer can devise a compound that will meet specifications, but it is well for the materials engineer to know what type of compound will meet his needs, and how it can be varied if difficulties arise.

A recent development in the phenolics illustrates how unusual formulating may be called upon to meet difficult conditions. Drawers for desks and tables have always been made of wood. The introduction of plywood assisted with the materials procurement problem, but did not greatly change the manufacturing methods. Wood is a low-cost material, and there seemed to be little opportunity for a substitution with a saving. However, sharply rising labor costs upset this equilibrium. The manufacture of wooden desk drawers requires about two hundred operations, so that high labor costs raised the total cost of the drawers to such a figure that the furniture industry began to show interest in possible alternate materials. Of the nonmetallics, the phenolic plastics, wood flour filled, showed the greatest promise. The problem became one of reducing costs, and in the case of an article made in one press operation this was largely a matter of reducing the cost of the material. The filler content of the general purpose phenolics might average about 50%, but under the need to reduce costs a phenolic was produced that contained about 90% wood flour. This material holds out prospects of a large new field for molded plastics.

In materials that vary so widely in composition, properties will show great variation also, so that a listing of typical properties can serve only as a general guide. The fields of usefulness of the types of plastics are well established, however, and these, with general values of properties, may indicate the possibilities of the material for specific uses.

Phenolics—The phenolics are the most widely used of the thermosets. They are lowest in cost, compatible with most fillers, hard, rigid, nonflammable (formulations high in wood flour filler may burn slowly), and have good durability. Chemical resistance is good, but they are attacked by strong caustic alkalies. They tend to discolor upon long exposure to light. The four broad types as given in Table 1, are differentiated on the basis of the type of filler used.

Chemically, the phenolics include phenol-formaldehyde plastics, phenol-furfurals, resorcinol-formaldehydes, mixtures of these, and blends with other materials, such as nitrile synthetic rubber. The phenol-formaldehyde plastics form the bulk of the phenolics used, but the other types offer some special properties that make them valuable for use with the phenol-formaldehydes, or alone. Some of the special features are:

Phenol-formaldehydes—lowest in cost; wide range of possibilities; general purpose.

Phenol-furfurals—excellent flow at temperatures low in the molding range, with quick cure in the 375 to 400 F range; excellent for molding intricate parts; possess good strength, good electrical properties, good dimensional stability.

Unbreakable compression molded phonograph record. (Courtesy B. F. Goodrich Chemical Co.)

Resorcinol-formaldehydes—good stability during storage; cure at low molding temperatures.

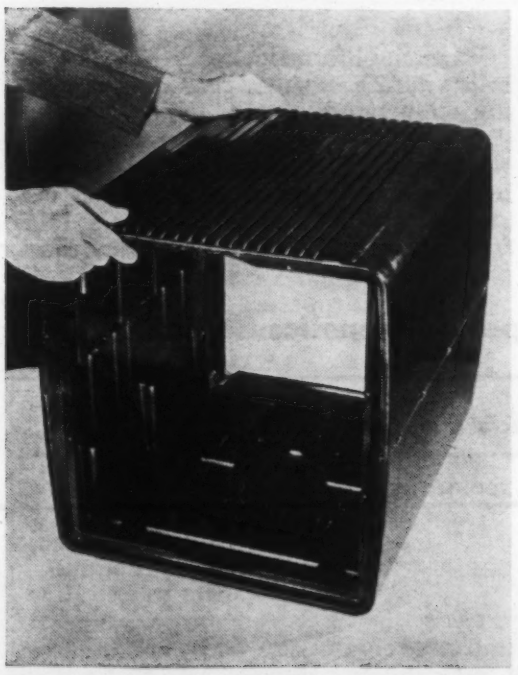
Phenolic-synthetic rubber blends—a wide range of molding materials, depending upon the percentages of rubber used and the type of filler. Materials range from rigid plastics made somewhat shock-

Table 1—Four Types of Phenolics

Type	Filler Used	Special Properties	Uses
General Purpose	Wood flour filled, with cotton flock or other filler sometimes added	Good moldability, low cost	For general decorative purposes, many electrical applications, radio cabinets, buttons, handles, etc.
Shock Resistant	Fibrous filler, as chopped cotton cord, chopped fabric, cotton flock, paper	Best impact strength, but moldability lowered	For gears, housings, etc.
Heat Resistant	Mineral filler, with some fiber added occasionally	Resistant to temperatures to about 450 F, (short time exposure), with moldability, machinability lowered	For cookware handles, knobs and handles for electric irons, toasters, etc.
Special Purpose	Mineral or organic, powder or fibrous, for specific use	Good electrical properties, chemical resistance, other properties as desired	Bearings, photographic developing tanks, electrical units, etc.

Table 2—Properties of Compression Molded Plastics

	Type	Tensile Strength, Psi	Heat Resistance, Continuous Service, F	Water Absorption, in 24 Hr, %	Chemical Resistance	Dielectric Str, Short Time, ⅛ In., V/Mil	Arc Resistance, Sec.
Phenol-Formaldehyde Plastics	General Purpose	4000-8000	325	0.5-1.0	Attacked by strong acids and caustics; good solvent resistance.	75-400	Poor
	Shock-resistant	6000-9000	250	0.5-1.7		200-400	Poor
	Heat-resistant	4000-7000	400	0.1-0.3		175-350	Poor
Phenol-Furfural Plastics	General Purpose	5000-8000	300	0.2-0.5	Attacked by strong acids; decomposed by strong alkalies; good solvent resistance.	300-550	—
Phenolic-Synthetic Rubber Blends	General Purpose	4000-9000	210	1.5	Attacked by strong acids and caustics; good solvent resistance.	300	20
Melamine-Formaldehyde Plastics	Alpha-cellulose Filled	7000-12,000	210	0.1-0.5	Decomposed by strong acids, attacked by strong alkalies; good solvent resistance.	300-400	100-175
	Mineral Filled	5000-7000	250-350	0.1-0.15		350-400	120-140
Aniline-Formaldehyde Plastics	Electrical, No Filler	8000-10,000	180	0.01-0.1	Decomposed by strong acids; attacked by strong alkalies; fair solvent resistance.	600	—
Urea-Formaldehyde Plastics	Alpha-cellulose Filled	6000-12,000	170	0.5-1.0	Decomposed by strong acids and alkalies; good solvent resistance.	300-400	100-150



This 17- by 16- by 20-in. television cabinet is molded in two pieces of 11 lb each. (Courtesy Bakelite Corp.)

resistant by addition of a small quantity of synthetic rubber to synthetic rubbers toughened by addition of a small quantity of phenolic. Compatible with most fillers.

Physical properties, etc., for the phenolics are given in Table 2.

Melamines—The melamines are more expensive than the phenolics, nearly white in color, and are compatible with most fillers. When made up with alpha-cellulose filler, they resemble the ureas. Impact-resisting grades are made with cotton or rag filler. They have practically unlimited color range, excellent dielectric strength, good heat resistance, good moisture resistance, and good chemical resistance.

Melamine plastics are used for buttons, food containers, tableware, instrument housings, electrical pieces, lighting fixtures, etc. Mineral-filled melamines are used for electrical applications.

Tabulated values for important properties are given in Table 2.

Aniline-formaldehydes—These plastics are more nearly specialty materials, somewhat more difficult to mold than the phenolics, not as versatile, but having especially good electrical resistance. They are attacked by strong acids, but have good resistance to moisture and organic solvents. They are thermoplastic rather than thermosetting, but have a high softening temperature, and a molding temperature of about 320 F. Colors are limited to darker shades. The material is used for ultrahigh-frequency insulation, for radio and television parts, terminal boards, etc.

Ureas—Urea-formaldehyde plastics are more expensive than the melamines, have less resistance to moisture, alkalies and acids, but have very high arc resistance, practically unlimited range of colors, good light transmission, will resist water up to about boiling temperatures, and excellent abrasion resistance. They are compatible with alpha-cellulose filler, and with little else. Lighting reflectors, electrical units, insulators, buttons, housings, closures, etc., are made from this type of plastics material.

Alkyd Molding Compounds—Excellent arc resistance, high-speed moldability, good chemical resistance are the principal advantages of a molding compound of alkyd resin. It is mineral-filled only, at present, and finds greatest use in electrical applications where its electrical resistance is desirable.

Polyesters—Primarily low-pressure laminating resins, the polyesters have recently been used in compression molding with glass fiber filler. They have good strength, good water resistance, chemical resistance, and good electrical properties. They can be produced in a wide range of colors. The polyesters are fast-curing thermosets, and cure at about 310 F under relatively light pressures.

Acknowledgments

Individuals or literature from the following companies have been consulted in the preparation of this manual.

American Cyanamid Co.
Bakelite Div., Union Carbide and Carbon Co.
Borden Co., Chemicals Div.
Catalin Corp. of America
Ciba Co., Inc.
E. I. du Pont de Nemours & Co., Inc.
Durez Plastics & Chemicals, Inc.
General Electric Co.
B. F. Goodrich Chemical Co.
Monsanto Chemical Co.
Plaskon Div., Libbey-Owens-Ford Glass Co.
Richardson Co.
Rohm and Haas Co.

Materials Engineering File Facts

NUMBER 208
May, 1951

MATERIALS DATA SHEET

Austenitic Stainless Steels

Austenitic, or chromium-nickel, stainless steels are the most widely applied of the various types chiefly because of their good formability. They are not magnetic or hardenable by heat treatment, but cold working makes them somewhat magnetic, increases their hardness. Also included are the extra-low-carbon (ELC) steels which are designed to eliminate the harmful carbide precipitation due to welding to which their counterparts are subject.

Typical Properties

PROPERTY / TYPE	301	302	303	304 and 304 ELC
COMPOSITION, %	0.08-0.20 C; 2 max Mn; 1 max Si; 0.04 max P; 0.03 max S; 16-18 Cr; 6-8 Ni	0.08-0.20 C; 2 max Mn; 1 max Si; 0.04 max P; 0.03 max S; 17-19 Cr; 8-10 Ni (AISI specs)	0.15 max C; 2 max Mn; 0.07 min P, S or Se; 1 max Si; 17-19 Cr; 8-10 Ni; 0.60 max Mo or Zr.	0.08 max C (304); 0.03 max C (304 ELC); 2 max Mn; 1 max Si; 0.04 max P; 0.030 max S; 18-20 Cr; 8-11 Ni
PHYSICAL PROPERTIES				
Density, Lb/Cu In.	0.29	0.29	0.29	0.29
Melting Point Range, °F	2550-2590	2550-2590	2550-2590	2550-2650
Thermal Cond, Btu/Hr/Sq Ft/Ft/°F @ 212 F	9.4	9.4	9.4	9.4
Coeff of Exp. per °F	9.5×10^{-6} @ 32-600 F	9.9×10^{-6} @ 32-212 F	9.9×10^{-6} @ 32-212 F	9.9×10^{-6} @ 32-212 F
Spec. Ht., Btu/Lb/°F @ 32-212 F	0.12	0.12	0.12	0.12
Elect Res, Microhm-Cm[3] @ 68 F	72	72	72	72 @ 70 F
MECHANICAL PROPERTIES[a]				
Mod of Elast in Tension, Psi	28.0×10^6	28.0×10^6	28.0×10^6	28.0×10^6
Tensile Str, 1000 Psi:				
Annealed	110, 105, —,	90, 90, 85	—, —, 90	85, 85, 85
Cold Worked[c]	185, —, —,	—, —, 110[b]	—, —, 110[b]	—, —, 110[b]
Yield Str, 1000 Psi:				
Annealed	40, 40, —,	40, 35, 35	—, —, 35	35, 30, 35
Cold Worked[c]	140, —, —,	—, —, 75[b]	—, —, 75[b]	—, —, 75[b]
Elong in 2 In., %:				
Annealed	60, 55, —	50, 60, 60	—, —, 50	50, 60, 60
Cold Worked[c]	8 to 9, —, —,	—, —, 35[b]	—, —, 30[b]	—, —, 60
Reduction of Area, %:				
Annealed	—, 70, —	—, 70, 70	—, —, 55	—, 70, 70
Cold Worked		—, —, 60[b]	—, —, 50[b]	
Hardness Bhn:				
Annealed	R_b85, —, —,	R_b85, R_b80, 150	—, —, 160	R_b80, 150, 150
Cold Worked	R_c41, —, —,	—, —, 240[b]	—, —, 240[b]	—, —, 240[b]
Impact Str, Izod, Ft-Lb:				
Annealed	—, 165, —	—, 110, 110	—, —, 80	—, 110, 110
Cold Worked				—, —, 90[b]
Fatigue Str (End Limit), 1000 Psi:				
Annealed	35, 39, —	—, —, 34	—, —, 35	35, 35, 34
Cold Worked	80, —, —			
Creep Str, Load for 1% Elong in 1000 Hr, Psi:				
@ 1000 F	—	17,000	—	17,000
@ 1300 F	—	4000	—	4000
@ 1500 F	—	1200	—	1200
THERMAL TREATMENT				
Annealing Temp, °F	1850-2050 and cool rapidly	1900-2050 and cool rapidly	1850-2050 and cool rapidly	1900-2050 and cool rapidly.
Hardening Temp, °F	Hardenable by cold working only			
FABRICATING PROPERTIES				
Ave. Forging Temp, °F	2200 start	2100 start	2100 start	2200 start
	Finish all grades at 1700 or above			
Machinability	—	Fair, tough	Good, about 65% of screw stock	Fair, tough
Weldability	Very good	Not recommended, may crack		Very good
CORROSION RESISTANCE				
Resist to atmosphere	Very good—slightly less than Type 302	Excellent—resists atmosphere, food products, acids, chemicals for textile, chemical, pulp, paper industries.	Very good—some resistance sacrificed for better machinability.	Excellent—slightly better than Type 302.
AVAILABLE FORMS	Sheet, strip and wire	Sheet, strip, plate, bar and wire	Bar and wire	Sheet, strip, plate, bar and wire
USES	Light weight, high strength, transportation equipment, roof drainage, trim	General purpose applications	Similar to those for Type 302 but where better machinability is required	304: Light, welded construction where corrosive conditions are not too severe.

(Continued on page 101)

Another cost-saving advantage for users of

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B&W MECHANICAL TUBING

TYPES—Seamless (hot finished and cold drawn). Welded (from hot or cold rolled strip).

GRADES—Carbon, Alloy, and Stainless.

SIZES—Up to 8⅝" O.D. in full range of wall thicknesses.

QUALITY—Open-hearth and electric furnace steels, including aircraft and magnaflux qualities.

CONDITION — Unannealed, annealed. tempered, normalized, or otherwise heat-treated as required.

SURFACE FINISHES — As rolled, as drawn, as welded, bead removed, turned, scale-free, and polished.

SHAPES — Round, square, rectangular, and special shapes.

B&W SEAMLESS and WELDED TUBES

TA-1509

THE BABCOCK & WILCOX TUBE COMPANY • *General Offices:* Beaver Falls, Pa. • *Plants:* Alliance, Ohio and Beaver Falls, Pa.

Materials Engineering File Facts

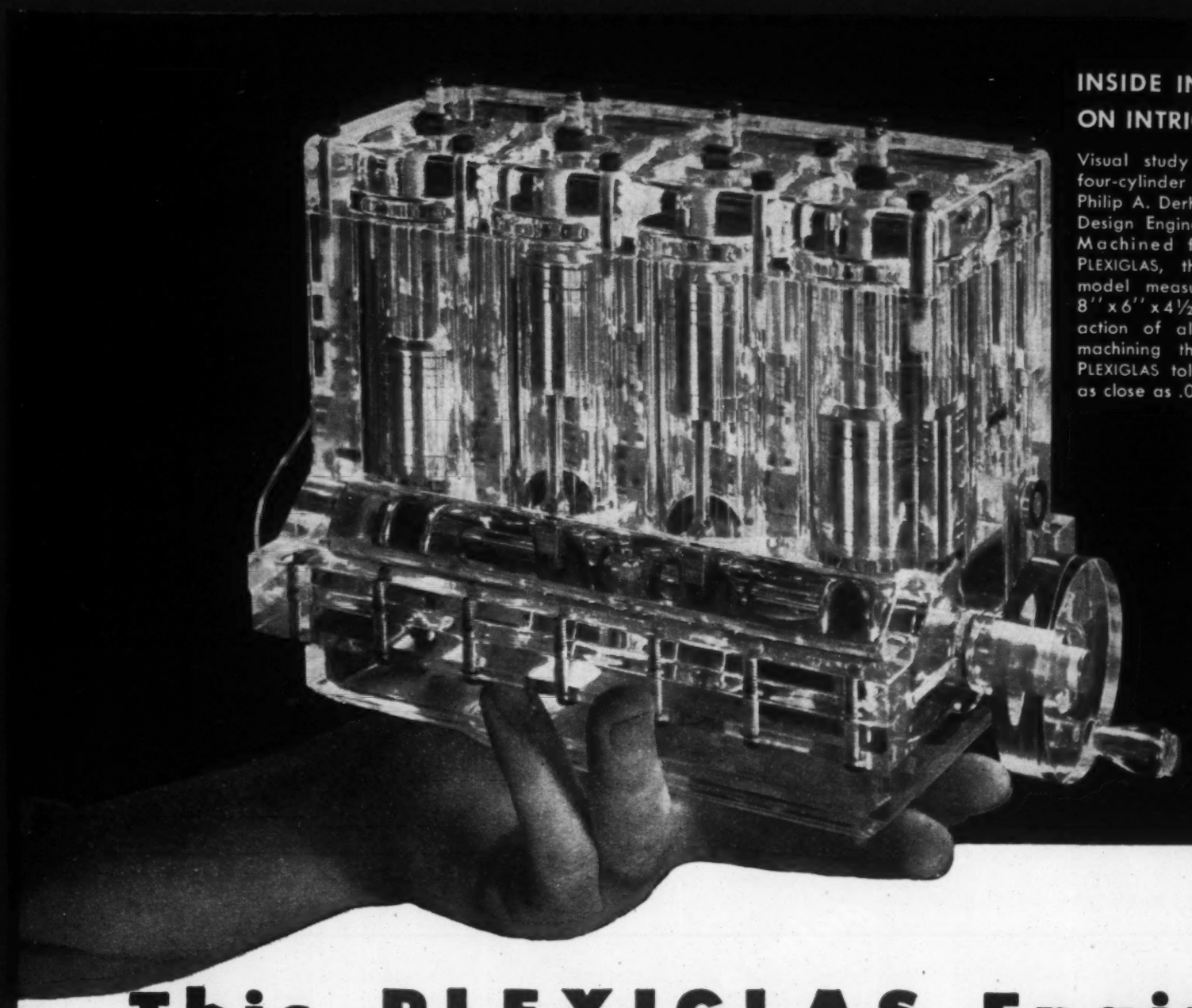
NUMBER 208 (Continued)

AUSTENITIC STAINLESS STEELS

PROPERTY \ TYPE	309	316 and 316 ELC	321
COMPOSITION, %	0.20 max C; 2 max Mn; 0.04 max P; 0.03 max S; 1 max Si; 22-24 Cr; 12-15 Ni	0.10 max C (316); 0.03 max C (316 ELC); 2 max Mn; 1 max Si; 0.04 max P; 0.03 max S; 16-18 Cr; 10-14 Ni; 2-3 Mo	0.08 max C; 2 max Mn; 1 max Si; 0.04 max P; 0.03 max S; 17-19 Cr; 8-11 Ni; 5 x C Ti
PHYSICAL PROPERTIES			
Density, Lb/Cu In.	0.29	0.29	0.29
Melting Point Range, F	2550-2650	2500-2550	2550-2600
Thermal Cond, Btu/Hr/Sq Ft/ Ft/°F, @ 212 F	8	9.4	9.3
Coeff of Exp per °F	9.3×10^{-6} @ 32-600 F	9.0×10^{-6}	9.5×10^{-6} @ 32-600 F
Spec Ht, Btu/Lb/°F @ 32-212 F	0.12	0.12	0.12
Elect Res, Microhm-Cm.[3] @ 68 F	78	74	72 @ 70 F
MECHANICAL PROPERTIES[a]			
Mod. of Elasticity in Tension, Psi	29.0×10^6	28.0×10^6	28.0×10^6
Tensile Str, 1000 Psi:			
Annealed	90, 95, 95	90, 85, 80	90, 85, 85
Yield Str, 1000 Psi:			
Annealed	45, 40, 40	40, 35, 30	35, 30, 35
Elong in 2 In., %:			
Annealed	45, 45, 45	50, 55, 60	50, 55, 55
Reduction of Area, %:			
Annealed	—, —, 65	—, —, 70	—, —, 65
Hardness, Bhn:			
Annealed	R_b85, 170, 160	R_b85, 150, 150	R_b80, 160, 150
Impact Str, Izod Ft-Lb:			
Annealed	—, —, 110	—, —, 110	—, —, 110
Fatigue Str (End Limit), 1000 Psi:			
Annealed		39, 39, 38	—, —, 38
Creep Str, Load for 1% Elong in 10,000 Hr, Psi:			
@ 1000 F	15,900	25,000	18,000
@ 1300 F	4500	7900	4500
@ 1500 F	1000	2800	850
THERMAL TREATMENT			
Annealing Temp, F	1900-2050 and cool rapidly	1850-2050 and cool rapidly	1900-2050 and cool rapidly
Hardening Temp, F	Hardenable by cold working only		
FABRICATING PROPERTIES			
Ave Forging Temp, F	2150 start	2200 start	2250 start
	Finish all grades at 1700 or above		
Machinability	Fair, tough	Fair, tough	Fair, tough
Weldability	Good	Very good	Very good
CORROSION RESISTANCE			
Resist to atmosphere	Excellent—better than Type 302. Resists destructive heat scaling up to 2000 F	Best corrosion resistance of any standard stainless steel. Greater resistance than Type 302 to reducing acids, sea water and other corrosive media causing pitting type of corrosion. Intergranular corrosion due to welding eliminated in 316 ELC	Excellent—similar to Type 302. Not subject to harmful carbide precipitation.
AVAILABLE FORMS	Sheet, strip, plate bar and wire	Sheet, strip, plate, bar and wire	Sheet, strip, plate bar and wire
USES	Heat resisting applications	316: Processing equipment exposed to severe corrosive media. Stressed parts that operate at high temperatures 316ELC: Equipment subject to severe corrosive conditions. Must be used at temperatures below 800 F	Welded equipment used in the unannealed condition and exposed to corrosive conditions. Equipment which must operate in the sensitization range (800-1650 F)

NOTES: [a] *Where three numbers are given, values represent sheet, plate and bar forms, in that order.*
[b] *Cold drawn—high tensile 1½-in. dia bar.*
[c] *Represents minimum value at full hard temper.*

This chart was prepared with the assistance of the Carnegie-Illinois Steel Corp. and Armco Steel Co.



INSIDE INFORMATION ON INTRICATE DESIGNS

Visual study model of typical four-cylinder gasoline engine, by Philip A. Derham and Associates Design Engineers, Rosemont, Pa. Machined from solid, clear PLEXIGLAS, the hand-operated model measures approximately 8'' x 6'' x 4½'', and illustrates the action of all moving parts. In machining the intricate model PLEXIGLAS tolerances were held as close as .001".

This PLEXIGLAS Engine Tells Its Own Inside Story

You can look right into this miniature gasoline engine—see every part and check every detail of operation. Machined from solid transparent PLEXIGLAS acrylic plastic, the hand-operated model shows clearly the action of pistons, valves, cams, connecting rod and crank shaft—from any angle.

Clarity, workability, light weight and durability make PLEXIGLAS especially useful in visual study models, demonstration models, and in general product design and engineering work. It machines easily to close tolerances—forms to almost any curvature when heated—is extremely strong even in very thin sections—and is readily cemented to form strong bonds.

These properties—plus gleaming beauty, a complete range of transparent and translucent colors, and resistance to weather and breakage—give PLEXIGLAS ever-growing importance in *full-scale* manufacturing and merchandising. We'll be glad to send you information on PLEXIGLAS sheets —flat, corrugated, and patterned—and on PLEXIGLAS molding powders.

CHEMICALS FOR INDUSTRY

A steadily increasing percentage of PLEXIGLAS production, now at record levels, is required for the defense mobilization program. The supply available for civilian applications is limited.

PLEXIGLAS is a trade-mark, Reg. U. S. Pat. Off. and in principal foreign countries.
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ROHM & HAAS COMPANY

WASHINGTON SQUARE, PHILADELPHIA 5, PA.

Representatives in principal foreign countries

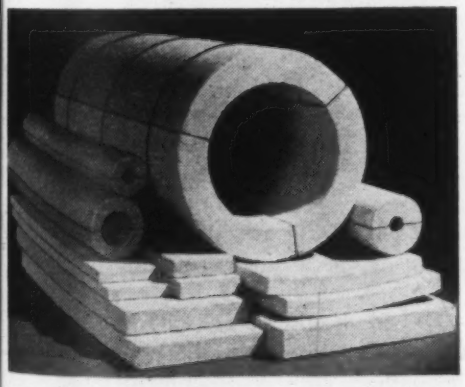
New Materials and Equipment

Materials & Parts

Heat Insulation Material

With the addition of curved block to the line, Kaylo heat insulation has been made available in a complete range of sizes and thicknesses by *Owens-Illinois Glass Co.*, Box 1035, Toledo 1. The range covers tubes and pipes from ¼-in. dia to 72 in. and vessels up to 60 ft.

Made of hydrous calcium silicate, which is said to insulate effectively up to 1200 F, Kaylo heat insulation is offered in all standard sizes of block and in thicknesses of from 1 to 6 in. for flat surface insulation. As pre-formed pipe covering it is made in sectional form (two pieces to the circumference) for all standard tube or pipe diameters from ¼ to 12 in.; tri-segmental form (three pieces to the circumference) for pipes and tubes up to 23 in.; quad-segmental (four pieces to the circumference) for pipes and tubes up to 41 in.; K-segmental (curved pieces 18 in. wide) for pipes and tubes up to 72 in.; and curved block nominally 18 in. wide for large vessels up to 60 ft in dia.



Kaylo heat insulation is said to insulate effectively up to 1200 F.

All pipe covering is made to simplified dimensional standards, which means that the outside diameters of the pipe coverings correspond to the outside diameters of standard pipes. Coverings, therefore, can be nested.

According to the manufacturer, several characteristics of the insulation help to reduce installation costs:

1. Extreme lightweight (11 lb per cu ft) makes it easy to handle.
2. High strength minimizes breakage and makes possible the large sizes, which mean fewer pieces are needed to cover a given area.
3. Insolubility in water—cuts water damage.

Silicon Steel

Development of an improved oriented electrical steel for use in wound transformer cores has been announced by *Armco Steel Corp.*, Middletown, Ohio.

Available in two grades, Tran-Cor 3W and Tran-Cor 4W, the new silicon steel is said to have an exceptionally low core loss and high permeability. Tran-Cor 4W has a core loss limit of only 0.64 watts per lb at 15 kilogausses and 60 cycles when tested under the conditions recommended for its commercial application. The corresponding limit for Tran-Cor 3W is 0.71 watts per lb.

Designed for use exclusively in wound cores requiring thin gage material, both grades are supplied in coils 1 to 30 in. wide and 0.012 in. thick. They are not recommended for stacked cores.

The surface of the steel insures negligible interlaminar loss in distribution transformers even when cores are annealed. Since the steel comes fully annealed, a maximum temperature of 1475 F will remove stresses produced by core winding.

Good permeability of the new grades permits this operation at inductions over 15 kilogausses and utilization of their low core loss.

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Testing & Control	126

Silver-Clad Steel

A laminated strip product, consisting of a solid sheet of silver clad on either one or both sides of a core of mild steel, has been developed by the *Rolled Plate Div.* of *American Silver Co., Inc.*, Flushing, N. Y.

Available in widths up to 4-in. thicknesses down to 0.005 in., and in any required temper, the silver-clad steel strip is being manufactured in various silver-to-steel thickness ratios and rolled and slit to commercial or precision tolerances. The strip is produced with a high, as-rolled luster which is said to require practically no polishing, and can, if desired, be electroplated directly with gold or other non-restricted metals.

Silver-clad steel can be used as a substitute for brass, nickel-silver, nickel and other restricted metals subject to NPA Order M-47. It can be shaped by stamping, bending, drawing, spinning and other conventional methods, and component parts can be assembled by means of silver brazing

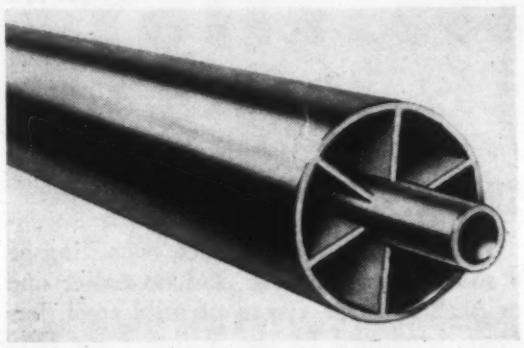
New Materials and Equipment
(CONTINUED)

and soft soldering. According to the manufacturer, the excellent thermal and electrical conductivities and the high resistance of silver to attack by alkalies and organic acids have already secured for the new product a wide field of industrial applications, ranging from aircraft engine bearings and electrical contacts to chemical equipment.

Concentric Radial Fin Tubing

Development of a new two-fluid-pass heat transfer surface in the form of concentric tubing with radial fins has been announced by the *Industrial Div.* of *Modine Manufacturing Co.,* Racine, Wis.

Originally designed for a specific application involving low temperatures and high pressures, Modine CRF tubing is said to possess characteristics which excellently adapt it to many other uses, such as gas liquefaction, food and pharmaceutical



This concentric tubing has been made with six radial fins and in diameters of 1 and 1⅜ in.

processing, condensing, exhaust heat recovery, and heating requirements involving viscous materials.

According to the manufacturer, the tubing can be fabricated of copper, steel, stainless steel, nickel and other metals in lengths up to 20 ft, and it is suitable for a wide range of temperature and pressure requirements. For maximum heat transfer, intimate contact is accomplished by means of fusion bonding of fin and tube elements.

Because of its specialized character, the tubing is necessarily engineered to meet individual application and is, therefore, currently offered only in production-lot quantities.

Gasketing Material for High Vacuum

A new synthetic rubber gasketing material with low vapor pressure has been announced by the *Distillation Products Industries Div.* of *Eastman Kodak Co.,* 727 Ridge Rd. W., Rochester 3, N. Y.

Myvaseal, a synthetic elastomer product, is said to be quite soft, have high abrasion resistance, and be moderate in price. Under standard test conditions, the material has been found to have a lower outgassing pressure than any other material available for this purpose.

Applications for the new product include parts of electron tube exhaust machines, television picture-tube pumping systems, and rotary exhaust systems. The material is available in molded, extruded or sheet form.

Ductile Bismuth Wire and Ribbon

Fitzpatrick Electric Supply Co., 444 Irwin St., Muskegon, Mich., has announced the production of ductile bismuth wire and ribbon designed to permit engineers to make useful applications of a material possessing unique electrical properties.

According to the manufacturer, the brittleness and lack of tensile strength formerly attributed to bismuth have been largely overcome. They claim to have bismuth ductile enough to wind on its own diameter at room temperature (70 F). However, since its tensile strength is low, the material has to be handled with care—that is, it should not be subjected to a strain exceeding its tensile strength. With this in mind, it is said to be possible to wind coils, make noninductive prods and make transformers without failure.

Possibilities of development in the control and instrument fields by the use of ductile bismuth are claimed to be tremendous, as the material offers the following advantages:

1. Resistance change in magnetic field.
2. Voltage change due to Hall effect.
3. A variable rectifier.
4. Hot and cold junction for instrumentation, refrigeration, etc.
5. Most negative material known for thermocouples.

Coatings & Finishes

Inhibitor for Shellac

Development of an inhibitor to protect shellac and other nonaqueous liquids from metal contamination has been announced by the *Merrimac Div.* of *Monsanto Chemical Co.,* Everett, Mass.

According to the producer, Inhibitor 03 is especially valuable in view of NPA restrictions on shellac containers. The new product is said to prevent iron pick-up b forming a thin coating of a complex iro phosphate on the inner wall of the co tainer.

Tests indicate that ½ to 1% of th inhibitor in 8-lb. terne-coated containe provided satisfactory protection from iro contamination for a minimum shelf life o one year.

Plastic Protective Coating

Production of a new, air-drying protec tive coating designed to protect tanks, tan cars, pipes, fittings, structural steel part and chemical processing equipment agains attack by splash, drip and spray from co rosive chemicals, corrosive atmosphere weathering and rust, has been announce by *United States Rubber Co.,* Rockefelle Center, New York 20.

Said to combine high film flexibility wit good adhesion and impact resistance, th plastic is expected to find its broadest us in chemical processing, rayon and cello phane production, photo finishing, pul and paper manufacturing, filtering and elec troplating, and in mining operations.

According to the producer, the coatin will not chip or crack, and can be used o steel, aluminum, concrete, hardwood c composition board. It is applied by spra allowing 1-hr drying time between coa and 24-hr drying time after the final coa Since the plastic contains no chemica plasticizer to leech out or harden, it r tains its flexibility throughout its servic life.

Metal should be grit-or sand-blasted b fore the coating is applied; cement shoul be etched with hydrochloric acid; whi wood and composition board need roug sanding to assure a good bond.

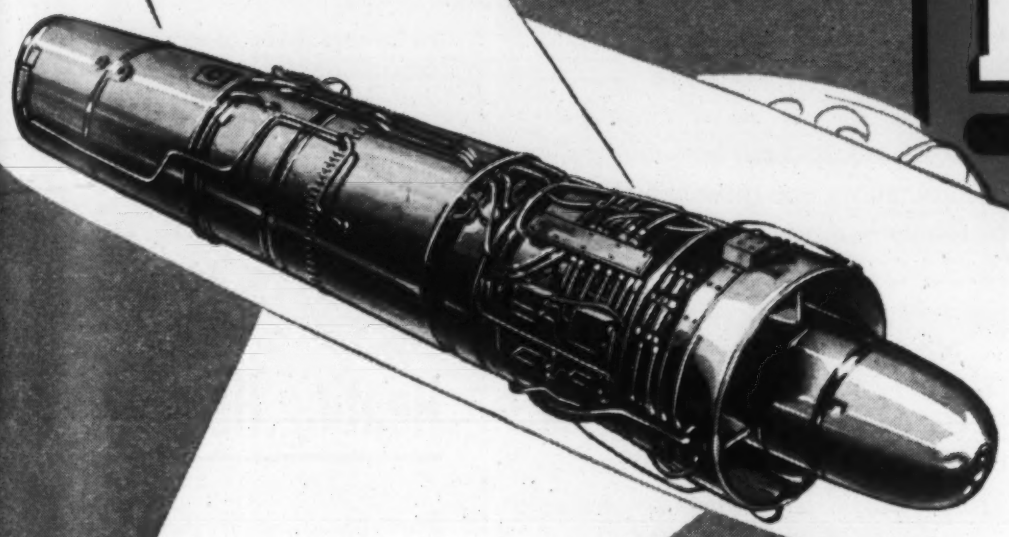
Protective Primer

Currently offered by *John W. Masury Son, Inc.,* 1700 Bayard St., Baltimore 3 is a new red oxide zinc chromate prim said to be a perfect mate for metals.

Conforming to Navy Specification #5 B-18, except for the use of iron oxi instead of titanium, Metyl-Mate is claim

Another First for...

N-A-X
ALLOY STEELS



The use of N-A-X ALLOY STEEL in Aircraft Gas Turbines saves up to 50 per cent of critical Stainless Steel.

Conservation is possible – without sacrifice with use of N-A-X ALLOY STEELS

With the demand for greatly increased quantities of the critical and strategic Stainless Steels used in Jet Engines intensified by the acceleration of the building program, the Air Force requested the producers of these engines to seek *suitable* material with less critical alloy content to replace the Stainless Steel for certain moderate temperature application in these aircraft gas turbines.

The steel selected had to be of low-alloy content with high strength and good welding characteristics. Ordinary low carbon steel did not meet the requirements because of its low tensile properties and the fact that it could not be satisfactorily welded by the inert arc process, which is widely used in aircraft gas turbine manufacture.

The data available from tests made on several weldable low-alloy, high-strength steels indicated that N-A-X ALLOY STEEL was the most satisfactory of the group — *its selection followed.* Unlike other possible substitutes, N-A-X ALLOY STEEL has good low temperature impact values, maintains its higher strength and is not subject to temper brittleness in the wide operating temperature range required of the steel for this purpose — from a low of −70°F. to +800°F.

The use of N-A-X ALLOY STEEL for this application has cut the amount of Stainless Steel required in half. This is of considerable importance to the Air Force.

GREAT LAKES STEEL CORPORATION

N-A-X Alloy Division — Ecorse, Detroit 29, Michigan

NATIONAL STEEL CORPORATION

A REGULAR SERVICE OF THE **COOPER ALLOY** FOUNDRY CO., HILLSIDE, N. J.

Technical Topics

MAGNETISM IN AUSTENITIC STAINLESS STEEL

Norman S. Mott
Chief Chemist and Metallurgist

In the normal specification range for the 18-8 chromium-nickel stainless steels, especially when the carbon is low, ferrite and the resultant magnetism will often be found. It must not be construed, however, that this condition is detrimental to the properties of stainless steel; in fact, in many cases it is highly desirable.

The fully austenitic stainless steels, when heated in the carbide precipitation range (900-1600° F.) have their carbon precipitated as chromium carbide along the grain boundaries. This depletes the boundaries of chromium with the result that the alloy becomes susceptible to intergranular corrosion.

When alloys containing amounts of ferrite from 5-15% are heated in this temperature range, it is found that the carbides tend to form predominantly in the ferrite areas. Since these areas are disconnected and well distributed, the condition does not promote intergranular corrosion.

Stainless steels with free ferrite up to 30% in amount retain good mechanical properties, although they show a slight decrease in ductility and toughness. Their strength and hardness are increased.

Estimation of the presence and approximate amount of ferrite may be accomplished by the use of a phase diagram based upon nickel and chromium equivalent values.* The nickel and chromium equivalent values are computed by the equations:

$$Ni^e = Ni\% + 0.5\,Mn\% + 30\,C\%$$
$$Cr^e = Cr\% + Mo\% + 1.5\,Si\% + 0.5\,Cb\%$$

The boundary line between fully austenitic alloys and those which contain ferrite is expressed by the equation:

$$Ni^e = \frac{(Cr^e - 16)^2}{12} + 12$$

When a higher percentage of nickel is specified in type 316 moly bearing alloys in order to make them completely austenitic in structure, they become susceptible to intergranular corrosion, and if they are to be heated in the carbide precipitation range, as would occur during welding, additions of columbium are required to counteract this susceptibility.

Molybdenum additions to 18-8 stainless make the alloy magnetic due to the formation of ferrite, and existing data have shown that the presence of this ferrite does not interfere with the high corrosion resistance of the alloy. In this form, it enjoys a wide range of usage where excellent resistance to corrosive media and the effects of welding heat are required.

*A. L. Schaeffler, Metal Progress, November, 1949, p. 680-B.

Available on request

Copies of this article, printed on heavy stock and in form convenient for filing, will gladly be sent to you, without obligation, in small quantities. You will find this excellent for answering problems that arise concerning the subject of magnetism in stainless steel. Address your requests to Publicity Dept., The Cooper Alloy Foundry Co., Hillside 5, N.J.

COOPER ALLOY
Stainless Steel
VALVES · FITTINGS · CASTINGS

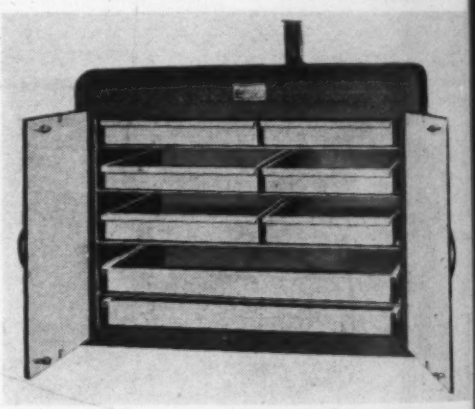
New Materials and Equipment

Heating, Heat Treatment

Portable Electric Oven

A new portable oven, the PL-1, with four shelves to provide for shelf processing, has been introduced by *Grieve-Hendry Co., Inc.*, 1101 N. Paulina St., Chicago, 22.

Products or materials can be placed directly on the shelves, which are said to have room for eight 2- by 12- by 23-in. long drying pans. Uses for the new oven include preheating plastic granules, treating powdered metals, and baking small electric components.



Four expanded metal shelves and a drip pan are standard equipment with this portable oven.

Constructed of steel with air-cell asbestos insulation, the unit operates from any 110-v outlet and requires no special wiring.

Brazing and Annealing Heating Unit

Development of a new, gas-fired production heating machine, designed for brazing plugs or adapters into ends of shell type units and for annealing mouths of shell cartridges, has been introduced by *Gas Appliance Service, Inc.*, 1211 Webster Ave., Chicago 14.

The heating zone in this unit consists of

Know Your Plastics

IT MAY MEAN BETTER AND FASTER PRODUCTION . . . AT LOWER COST

BAKELITE thermosetting Polyester Resins are combinations of styrene monomer and complex polyesters developed for contact pressure and low pressure molding, laminating, and casting. Polymerization is brought about by the use of catalysts, application of heat, or both. The resins are supplied as pale liquids in varying viscosities. They are produced in several grades, principal among which are detailed below.

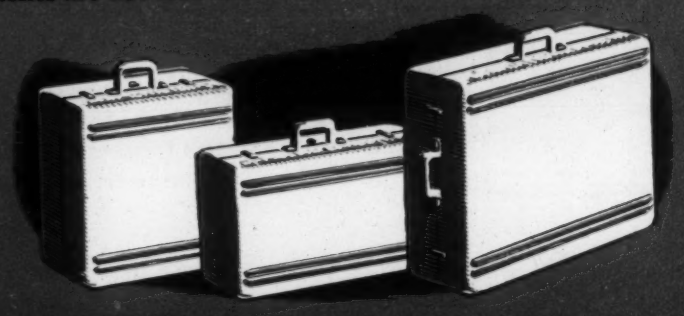
This message deals with "BAKELITE" POLYESTER RESINS

"BAKELITE" QRS-81 GENERAL PURPOSE

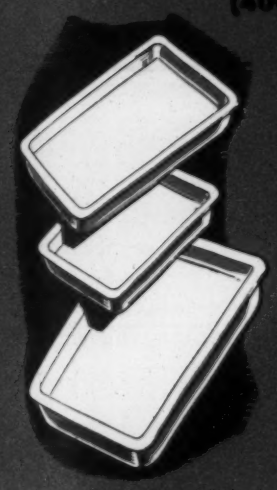
This general-purpose, liquid resin was developed for structural applications. It is particularly serviceable for matched-die molding because of its excellent moldability and easy flowing quality. Also readily formed with plaster, wood, and sheet-metal molds. Applicable to rubber-bag molding. Cures at room or elevated temperatures with standard catalysts. Does not precure. Retains excellent mechanical strength and electrical values at operating temperatures under 150 deg. F.

"BAKELITE" QRS-136 FLEXIBLE

This is a flexible resin sold as a non-plasticized liquid. It can be used alone for certain applications requiring a high order of toughness and flexibility, as in the production of tubing. However, it has been most useful to date as a modifier for other Polyester Resins to impart toughness and impact resistance in structural laminates and moldings. Compatible with most other Polyester Resins. Recommended for mechanical applications or where electrical insulating requirements are not critical.



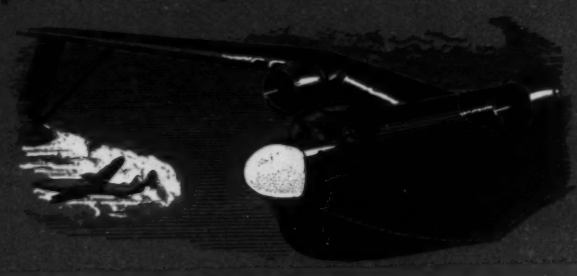
"BAKELITE" QRS-17560 HIGH VISCOSITY
(4000-6000 cst.)



Formulated for producing castings or moldings with fewer inherent stresses and strains than with other grades of Polyester Resins. Provides non-crazing pieces of high resin content, with or without filler. Where fillers are called for, smaller quantities are required. Because of versatility of this resin it is particularly satisfactory for the production of castings made from glass-fiber preforms.

"BAKELITE" QRS-140 MEDIUM VISCOSITY
(300-600 cst.)

This is a medium viscosity resin developed especially to meet the insulating requirements for high-frequency electronic apparatus and components (9375 megacycles per second). In electrical properties it approaches BRS-16631, so widely used in World War II for radomes and other vital equipment. It is easier to handle than BRS-16631 because of improved moldability.



The development of BAKELITE Polyester Resins for molding reinforced plastics is a continuing operation of the Bakelite Laboratories. Formulations can be varied almost infinitely, and tailored to your particular jobs. Some of these jobs . . . chiefly with glass fiber cloth or mat . . . include boat hulls, radomes, refrigerator panels, housings, luggage, to which they give light weight, high impact, tensile, and flexural strength, and resistance to moisture, many chemicals, and heat. Superior electrical insulation values are attainable. For instance, laminates made with these resins have relatively low power factors throughout the 60 to 10^6 cycles range. They eliminate the need for costly molds, high heat, and high pressures. Engineers and designers interested in BAKELITE Polyester Resins are urged to outline their needs *in fullest detail* for a thorough, confidential analysis. Write Dept. BV-17.

BAKELITE
TRADE-MARK
POLYESTER RESINS

TRADE B MARK

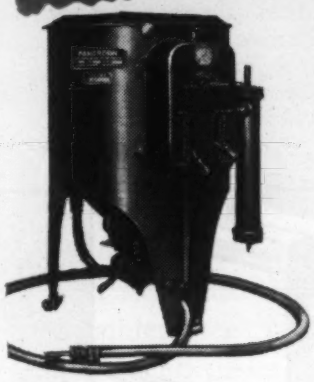
BAKELITE COMPANY
A Division of
Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, N. Y.

Here's how Pangborn

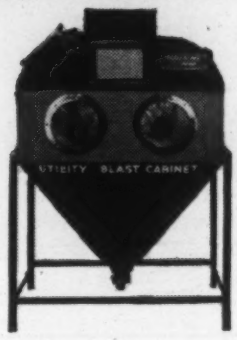
Solves these Problems

with this modern equipment

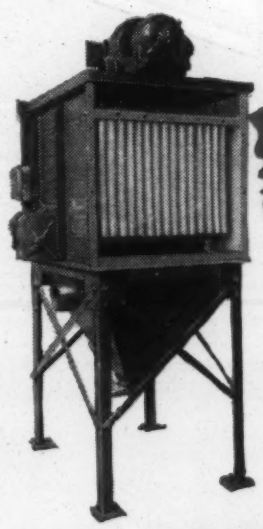
BLAST CLEANING!



Blast Cleaning Cabinet quickly and easily cleans rust, grime, dirt, paint, etc., from metal parts. Produces a clean, smooth surface on pieces up to 60″ x 36″. Models available from $315.00 and up.



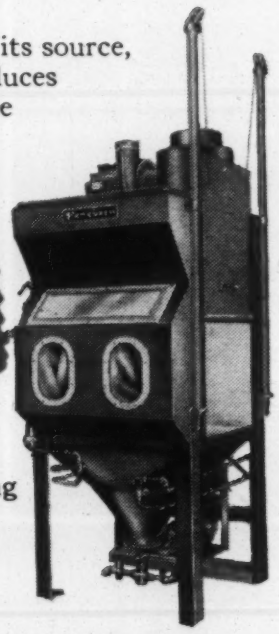
Blast Cleaning Machine not only removes rust, dirt, scale, etc., but is ideal for maintenance and many other uses. Cleans large objects such as bridges, structural work, tanks before painting. Six sizes, portable or stationary, from $170.00 and up.



DUST COLLECTING!

Unit Dust Collector stops dust at its source, minimizes machine wear and tear, reduces housekeeping and general maintenance costs. Solves many grinding and polishing nuisances. Reduces material losses. Models from $286.00 and up.

PRECISION FINISHING!



Hydro-Finish Cabinet uses liquid blast, eliminating dust, and reduces costly hand polishing, cleaning and finishing of molds, dies, tools, etc. Removes scale, discoloration and directional grinding lines, prepares surfaces for plating and coating. Holds tolerances to .0001″. Models from $1295.00 and up.

LOOK TO PANGBORN FOR THE LATEST DEVELOPMENTS IN BLAST CLEANING AND DUST CONTROL EQUIPMENT

Pangborn

MAIL COUPON for full details

(Check for more information)

- ☐ Blast Cleaning Cabinets
- ☐ Blast Cleaning Machines
- ☐ Unit Dust Collectors
- ☐ Hydro-Finish Cabinets

PANGBORN CORP., 1700 Pangborn Blvd., Hagerstown, Md.

Gentlemen: Please send me more information on the equipment I've checked at the left.

Name.....

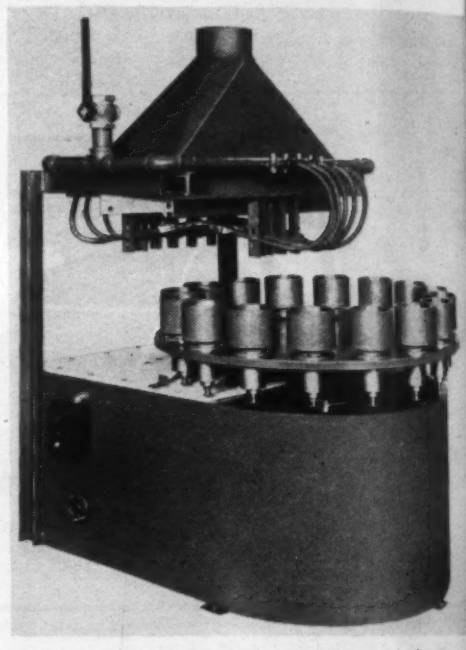
Company.....

Address.....

City.....Zone.....State.....

New Materials and Equipment

two rows of high-speed zig-zag burners which, with their high rate of heat output, bring the sections to be brazed or annealed to the proper temperature in a minimum of time. Confining the heat to the work area, the machine is said to eliminate the usual excessive heating of surrounding portions.



This gas-fired heating machine is designed for brazing or annealing shells.

According to the manufacturer, the machine produces 600 pieces per hr in a 60-in. dia unit. Other types and sizes of turntables or conveyor units are available for accommodating various diameter and production requirements.

Cleaning & Finishing

Surface Finishing Machines

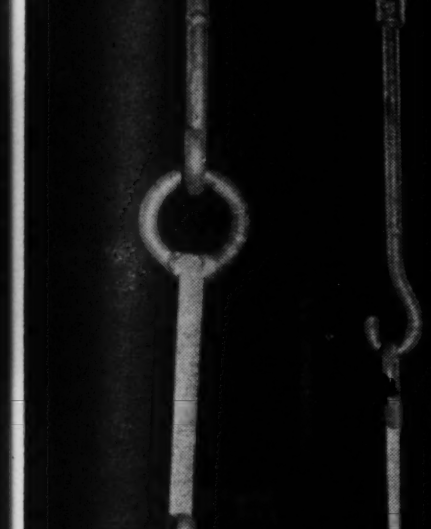
Recommended for application in producing a smooth wearing surface on shafts, rods, axels, tubing and pipe, the new surface finishing machines, marketed by *Storm-Vulcan, Inc.*, 2504 Commerce St., Dallas 1, Tex., are also said to be adaptable to automotive, railroad and general industrial use.

The surface finishing operation is claimed to take only a few seconds on surfaces that have been ground or turned to size, and belts of various grits are available for producing the surface best suited for any specific purpose and type of metal.

Used for polishing, surface finishing and

PANGBORN ROTOBLAST* CABINET CLEANS UP TO 200 ENGINE BLOCKS AN HOUR

at world's largest independent jobbing foundry



Loading the heavy cylinder blocks on the conveyor is easily handled by two men.

ROTOBLAST . . .

SAVES LABOR with push-button operation

SAVES SPACE because machines are compact

SAVES TIME by cleaning more loads per day

SAVES POWER since no compressor is needed

SAVES TOOLS because all scale removed

ABOVE: This rear view of Campbell, Wyant, Cannon's Pangborn "ES" ROTOBLAST Cabinet shows the conveyor system and four ROTOBLAST Machines. Inside the cabinet, the conveyor stops in front of each ROTOBLAST unit and slowly revolves the casting in the blast stream to assure complete cleaning.

BLAST CLEANING at Campbell, Wyant, Cannon Foundry Co., of Muskegon, Mich., is fast, efficient and *mechanized!* And the secret of this performance is two Pangborn "ES" ROTOBLAST Cabinets like that shown above. Heavy engine blocks can be cleaned at a rate of *200 an hour* . . . and cleaning is automatic! The result is faster, better, cheaper blast cleaning than ever experienced with other equipment.

Campbell, Wyant, Cannon started to mechanize their cleaning operation in 1937 . . . when they installed one of the first Pangborn monorail ROTOBLAST Cabinets. Later they installed a second Cabinet to meet production demands. As a result cleaning costs have been even further reduced, and there's no cleaning room bottleneck. Cleaning is a simple, automatic operation with high-quality work assured.

GET THE COMPLETE ROTOBLAST STORY: Bulletin 214 is informative and covers many applications. Write for your free copy to: Pangborn Corporation, 1700 Pangborn Blvd., Hagerstown, Md.

Look to Pangborn for the latest developments in Blast Cleaning and Dust Control equipment.

Pangborn

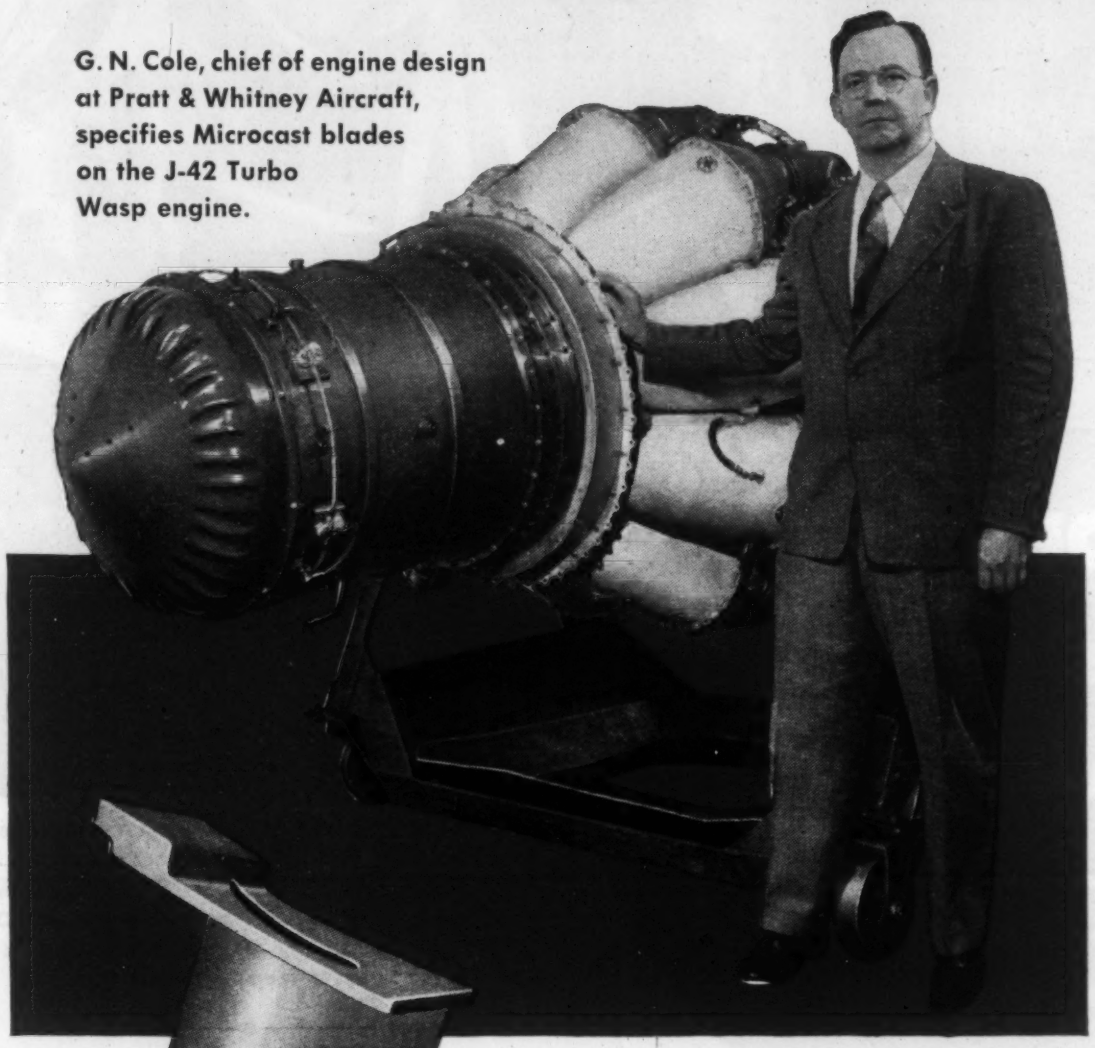
BLAST CLEANS CHEAPER

with the right equipment for every job

Microcast®

Means Power Blading

That's Performance-Proved



G. N. Cole, chief of engine design at Pratt & Whitney Aircraft, specifies Microcast blades on the J-42 Turbo Wasp engine.

THE MICROCAST PROCESS of precision casting for aircraft engine power blading, performance-proved in World War II, offers outstanding advantages to design engineers working on today's revolutionary power units. Superior to conventional production methods, Microcastings afford substantial dollar and labor economies, plus savings in critical alloys and elimination of tool breakage. Microcastings virtually eliminate machining, freeing machine tools for other work. Why not investigate the Microcast Process today?

FREE BOOKLET

The precision process originated by Austenal Laboratories, Inc. for the production of castings of intricate design using the high melting point alloys where surface smoothness and dimensional uniformity are mandatory, requiring little or no machining. Write for literature and complete information.

MICROCAST PRECISION CASTINGS PROCESS

MICROCAST DIVISION
AUSTENAL LABORATORIES, INC.
224 East 39th St., New York 16, New York
715 East 69th Place, Chicago 37, Illinois

MICROCAST

MICROCAST TRADE MARK REG. U. S. PAT. OFF.

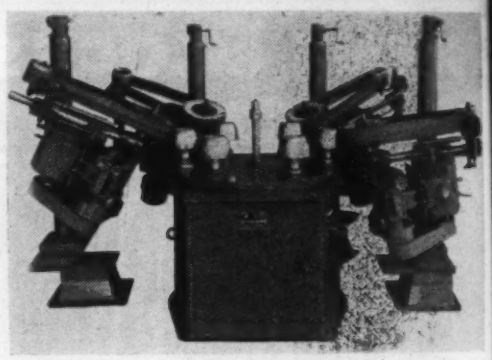
New Materials and Equipment

for actual sizing when only small amounts of stock need removing, the Kotafin machines are built to handle any length of shaft or rod up to 118 in. A special polishing compound available for use with these machines is said to impart a chromium-plated appearance to the surface.

Furnished as complete units or with attachments for any engine lathe and most shaft grinding machines, the finishing machines are also built for special applications.

Polishing Attachment

A newly developed polishing belt arm attachment, said to be universally adjustable from horizontal to vertical positions, has proved effective in a new 40-in. rotary automatic polishing and buffing machine ar-



This machine is a 6-station indexing rotary equipped with the new polishing belt arm attachment.

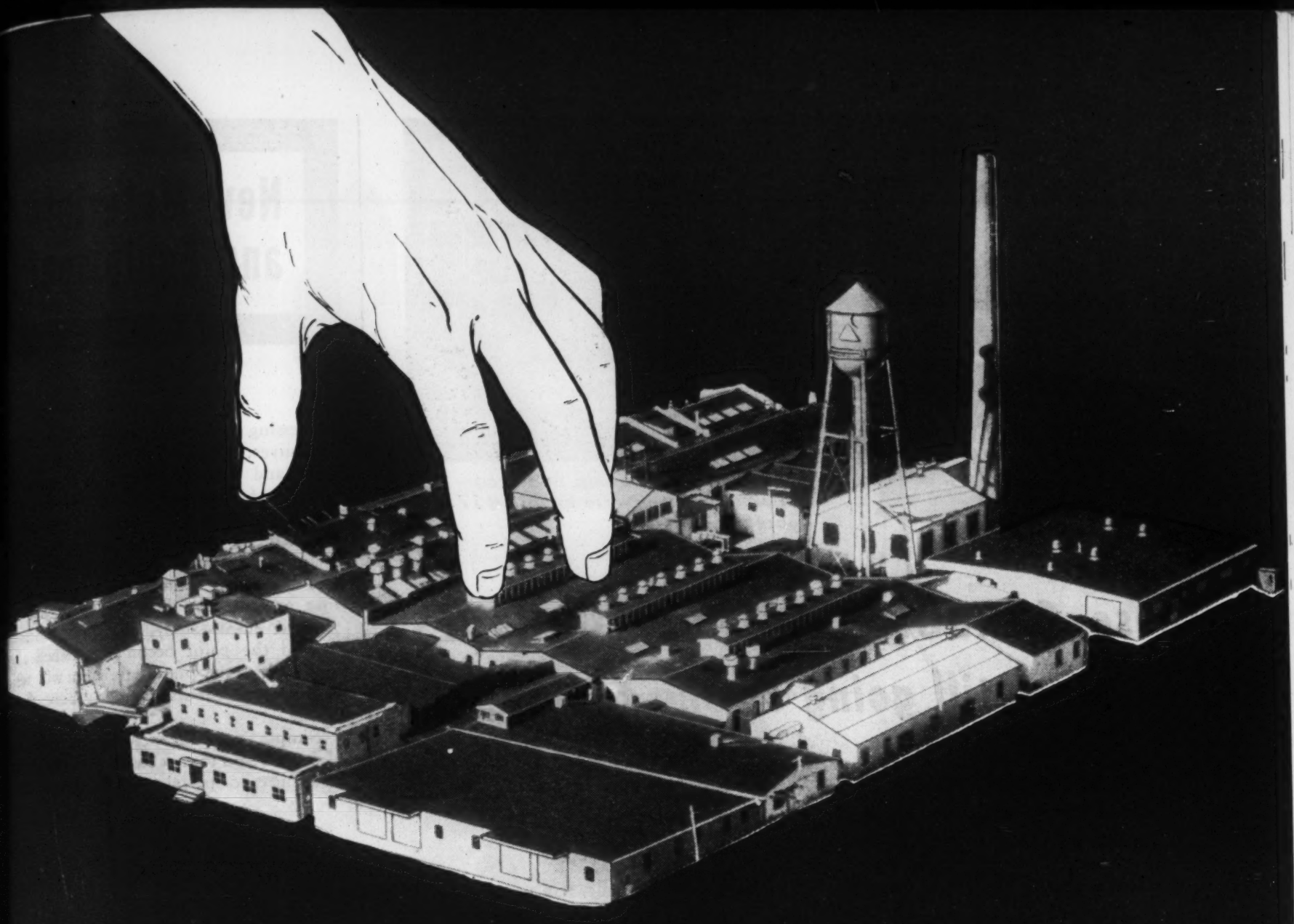
rangement offered by *Acme Manufacturing Co.*, Detroit.

This machine is a 6-station indexing rotary with four Acme type G-1 adjustable floating head buffing lathes equipped with the new polishing attachment, which is used for polishing automotive grille parts. With this attachment, Acme G-1 and G-3 lathes are readily converted to polishing belt heads.

Pre-Finish Metal Cleaner

A special acid phosphate cleaner developed expressly for the preparation of metal surfaces for painting, lacquering or japanning has been announced by *E. F. Houghton & Co.*, 303 W. Lehigh Ave., Philadelphia 33.

Houghto-Clean 313-A is said to condition metal for final finishing by removing



Raising the Roof at Aico . . .

Things have been humming at Aico. Every user of molded plastics has an interest in what has been going on in our big modern plant.

Raise the roof . . . take a look inside. You'll see a vast improvement program as it nears completion, to make Aico one of the most versatile, finest equipped of all plastic molders.

Big, new molding presses . . . the latest preheating and finishing equipment . . . rearrangement of production facilities . . . all contribute to producing better plastic parts through greatly improved scientific control of materials and sharply increased production efficiency.

Now, even more than before, Aico makes it possible to simplify your buying of plastic parts by placing all your orders under one roof. With complete compression, injection, cold molding and low pressure molding departments, Aico is one of the limited few plastic parts suppliers in a position to make an unbiased recommendation on the most practical and economical method of molding.

Our engineering people are here for the purpose of advising you on the proper use of molded plastics. The use of this service involves no obligation. Just drop us a line if you think we can be of assistance to you.

AMERICAN INSULATOR CORPORATION
NEW FREEDOM, PENNSYLVANIA

Aico's Complete Plastic Molding Service Includes:

ENGINEERING COUNSEL on proper molding methods and materials.

MOLD BUILDING to avoid division of responsibility.

INJECTION MOLDING for high rate of production . . . low unit cost.

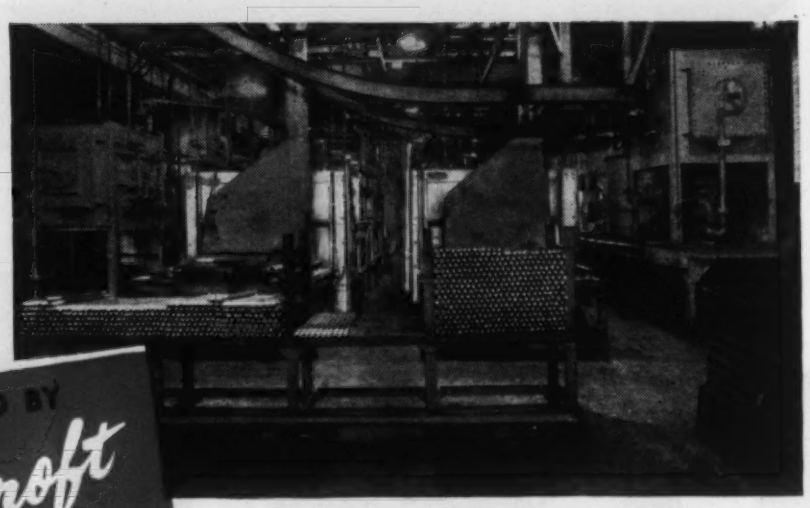
COMPRESSION MOLDING of large parts with heavy cross sections.

COLD MOLDING of electrical parts requiring high heat resistance.

LOW-PRESSURE MOLDING . . . a relatively new development especially suitable for short runs of large, lightweight pieces.

MANY THINGS ARE BETTER BECAUSE OF

Aico PRECISION MOLDED **plastics**



DEVELOPED BY Holcroft IN 1934 . . .

These two non-scaling, non-decarburizing furnaces were installed 17 years ago . . .

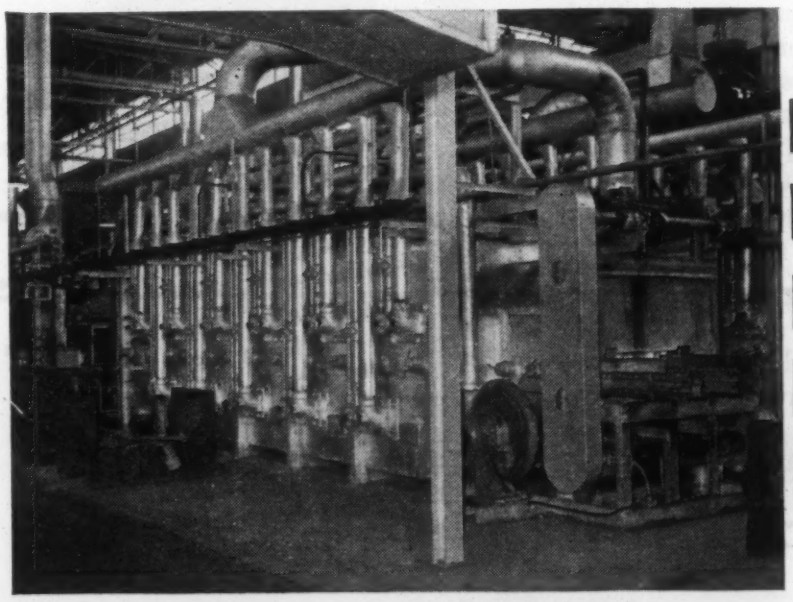
These CARBON-CONTROL FURNACES are still going strong today

Industry's first non-decarburizing furnaces for high carbon steel were built by Holcroft in 1934 . . . and are still in service today!

Since then, Holcroft research has been responsible for many more developments in the field of controlled atmosphere hardening. These Holcroft advantages are so well-known that almost all modern carbon-control furnaces follow the principles established by Holcroft engineers.

Other Holcroft furnaces are hanging up production records, too. If you have any kind of a heat treat problem, you can tap this fund of metallurgical know-how by writing today.

. . . one of three radiant tube furnaces recently built for the same customer.



BLAZING THE HEAT TREAT TRAIL

SINCE 1916 Holcroft AND COMPANY

BUILT BY HOLCROFT & COMPANY DETROIT, MICH.

PRODUCTION HEAT TREAT FURNACES FOR EVERY PURPOSE

6545 EPWORTH BLVD. DETROIT 10, MICHIGAN

CHICAGO 9 — C. H. Martin, A. A. Engelhardt, 4209 South Western Blvd.

CLEVELAND 15 — Wallace F. Schott, 1900 Euclid Ave.

HOUSTON 1 — R. E. McArdle, 5724 Navigation Blvd.

CANADA — Walker Metal Products, Ltd., Windsor, Ontario

EUROPE — S. O. F. I. M., Paris 8, France

New Materials and Equipment

processing oils and compounds, rust preventatives, perspiration and soldering residues, and then depositing a smooth, dry coating of phosphate on the metal surface to provide greater adhesion of the finishing material.

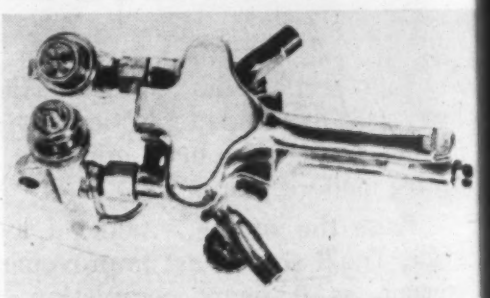
In addition to preparing the surface, the new cleaner is claimed to provide protection against rust. Parts cleaned, but not painted immediately, will not corrode. Should the paint become scratched after application, the phosphate film will resist rust and prevent its spreading beneath the paint.

Simple and inexpensive to use, the cleaner is said to mix easily with water and to require no special equipment.

Spray Gun

The Schori Process Div. of *Ferro-Co Corp.*, 8-11 43rd Rd., Long Island City 1, N. Y., has announced the development of a new, paint-type spray gun that is said to spray two solutions at the same time.

Designed to handle materials that are stable in themselves, but that cure quickly only when mixed with other materials, the



This new type spray gun features two nozzles and is said to spray two solutions at a time.

gun can spray formulations that become tack-free in 10 min.

Using two pots and a spray gun with two nozzles, the unit keeps the two solutions apart until they are mixed externally as the material is atomized. Thus, instead of a pot life measured in minutes, the method permits hours of pot life, and with some materials, days.

An example of how the equipment is used with Marco polyester resins follows: One-half of Marco MR-28C resin in which Marco catalyst has been dissolved is placed in one tank, and the other half of the resin is mixed with Marco accelerator and placed in the other tank. The resin-catalyst blend is said to remain stable for at least one working day and the resin accelerator blend for considerably longer. The two are mixed beyond the two nozzles which are provided

Tubing troubles got your goat?

Bundyweld Tubing, double-walled from a single strip. Exclusive, patented beveled edge affords smoother joint, absence of bead, less chance for any leakage.

If you're butting up against costly rejects, time-taking inspections, poor performance in your tubing unit, you ought to get the facts on Bundyweld.

This multiple-wall type of Bundy® tubing is double-rolled from a single strip, unmatched by any other tubing.

It's amazingly rugged, easy to form and fabricate. It conducts heat faster, and withstands gruelling vibration in lines and coils that have to take a shaking.

Right now, defense and essential production rate top call on Bundyweld, though we're doing everything possible to service all Bundy customers. Why not inquire regarding your needs?

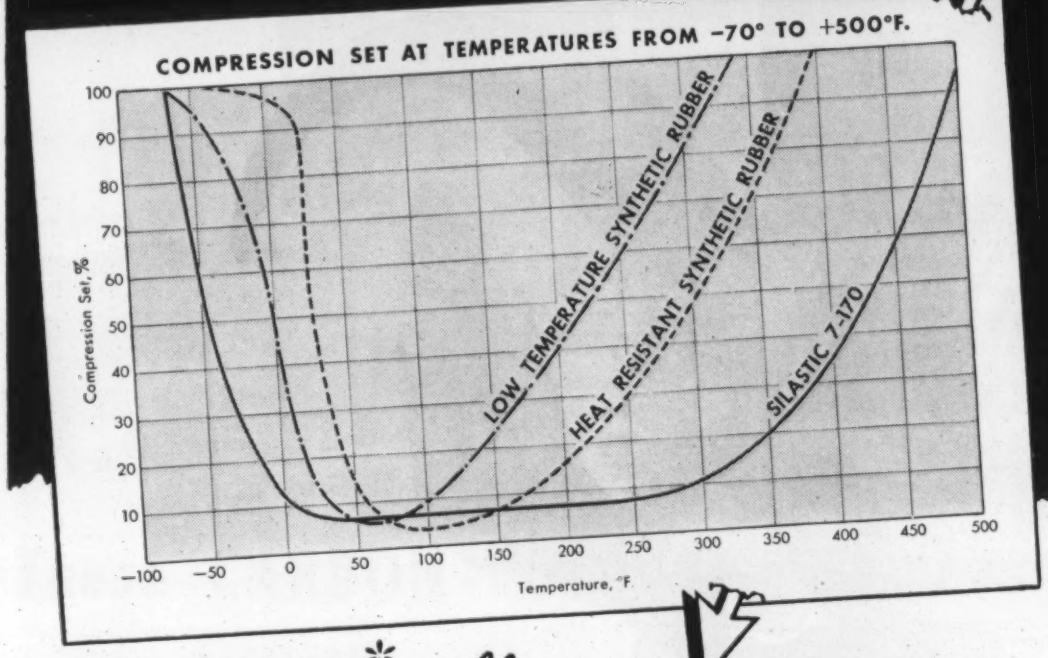
Bundy Tubing Company

DETROIT 14, MICHIGAN

World's largest producer of small-diameter tubing

AFFILIATED PLANTS IN ENGLAND, FRANCE AND GERMANY

Where ordinary rubber gaskets fail . . .



SILASTIC* still stays Elastic!

AT EXTREME TEMPERATURES, Silastic has greater resistance to compression set—or to permanent deformation due to heat and pressure—than any other rubberlike material. Its elastic memory exceeds that of both the best low temperature and the best high temperature organic rubbers available. Silastic 7-170 forms a more resilient seal at −50°F. than a special low temperature organic rubber does at −7°F. At 450°F., Silastic has more resistance to permanent compression set than the most heat-stable organic rubbers have at 330°F.

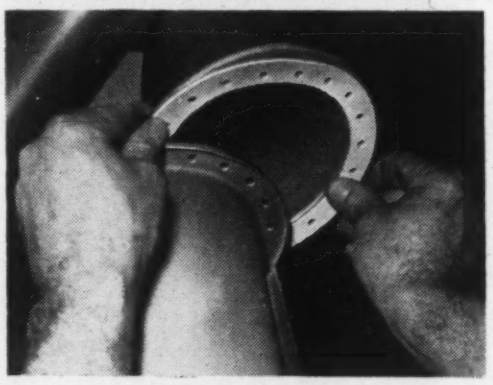
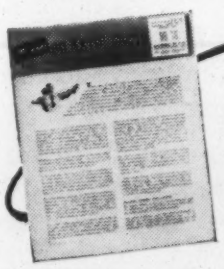


PHOTO COURTESY CONSOLIDATED VULTEE AIRCRAFT CORP.

In aircraft cabin heating and pressurizing systems, Silastic gaskets stay elastic under operating temperatures ranging from −70° to 400°F. Similarly, Silastic gaskets and O-rings withstand hot oils at about 450°F. in automotive, aircraft, diesel-electric engines.

Combine that kind of elastic memory with excellent resistance to aging, to oxidation and to attack by a variety of chemicals and hot oils, and you have Silastic—the most stable of all resilient gasketing materials. That's why design engineers and maintenance men specify Silastic, the Dow Corning Silicone rubber that pays for itself many times over in reduced maintenance costs and improved performance.

*T. M. REG. U. S. PAT. OFF.



SEND TODAY!
For your copy of Silastic Facts No. 10 containing new data on the properties, performances and applications for all Silastic stocks.

from +500°F. SILASTIC stays Elastic to −100°F.

DOW CORNING CORPORATION, DEPT. AF-5, MIDLAND, MICH.
Please send me Silastic Facts No. 10
Name_____
Company_____
Address_____
City_____ Zone ____ State_____

Dow Corning
FIRST IN SILICONES

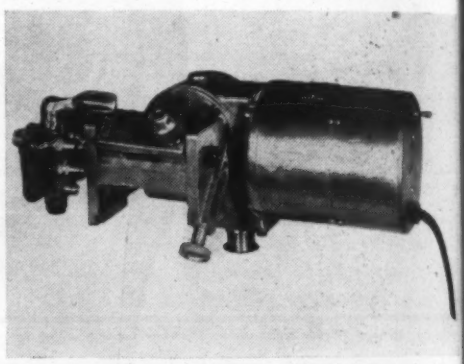
Atlanta • Chicago • Cleveland • Dallas • Los Angeles • New York • Washington, D. C.
In Canada: Fiberglas Canada Ltd., Toronto • In England: Albright and Wilson Ltd., London

New Materials and Equipment

in the gun. This permits the use of comparatively large proportions of accelerator, which is said to result in extremely rapid gelation—about 3 min. or less at 70 F while maintaining long pot life of the material in the tanks.

Metal Spraying Gun

Developed primarily for coating shafts, rolls or machine element parts from a lathe mounting, a new metal spraying gun has been introduced by *Metallizing Co. of America*, 3520 W. Carroll Ave., Chicago 24. Said to be virtually foolproof in per-



This new metal spray gun will spray #15 B&S gage wire up to 3/16-in. dia, from the lowest melting point metal to the highest.

formance, the Mogulectric features a greatly increased spraying speed and can also be used for spraying tanks and structural members.

Adding metal to metal via fine atomization of wire stock at 6300 F with a perfect bond in addition to rebuilding worn parts, the gun is claimed to be ideal for spraying corrosion resistant metal coatings and for reclaiming mismachined castings and machine parts.

Weighing 20 lb and powered with a 1/20-hp constant speed induction motor, the gun assures a uniform wire speed that can be adjusted to the type of metal being sprayed.

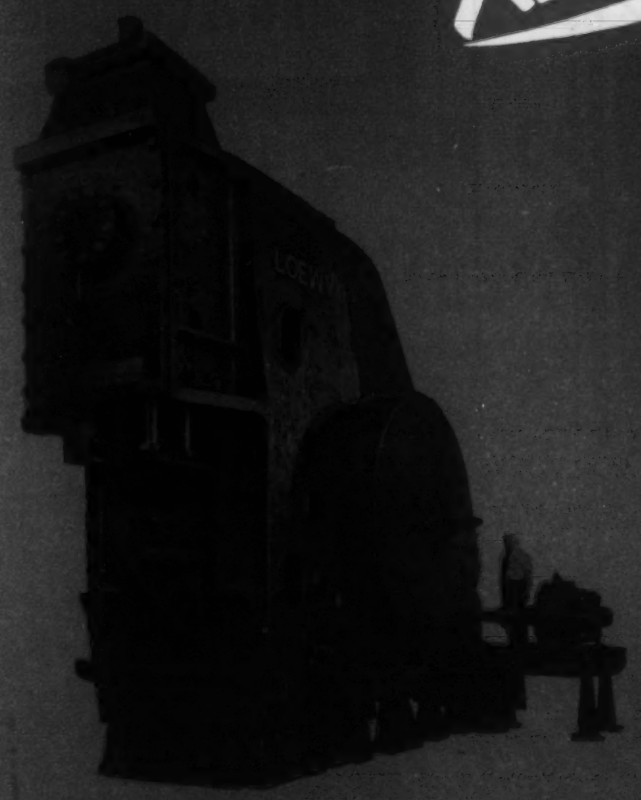
Chromium Anodes

A new type of chromium plating anode has been developed by *Hanson-Van Winkle-Munning Co.*, Matawan, N. J.

Called Chrome-Flo, the anode is said to offer the following advantages:

1. Insoluble chromate film formation on anodes is markedly decreased

HEAVY DUTY GIANT *REQUIRES* HIGH DUTY MATERIAL



MEEHANITE CASTINGS *SPECIFIED*

Illustrated is a giant billet shear and the main Meehanite housing casting used in its construction. This shear will cut a hot steel billet from 16″ x 16″ square bars and the severity of its operational requirements demand the superior properties of Meehanite castings for its main housing.

Of particular importance in this instance were the high tensile strength characteristics—50,000 psi minimum and the ability to absorb the vibratory stresses set up during operation.

The casting weighed 52 tons and the shear was designed and supplied by Loewy Rolling Mill Division, Hydro-Press, Inc., New York and built in the shops of Farrel-Birmingham Co., Inc., Ansonia, Connecticut.

The superior engineering properties of Meehanite castings are achieved without alloys;—important in times of shortages, stockpiling and today's materials problems.

MEEHANITE®

WHEN YOU NEED "EXTRAS" IN QUALITY OR PROPERTIES CONSULT ANY OF THE FOUNDRIES LISTED BELOW

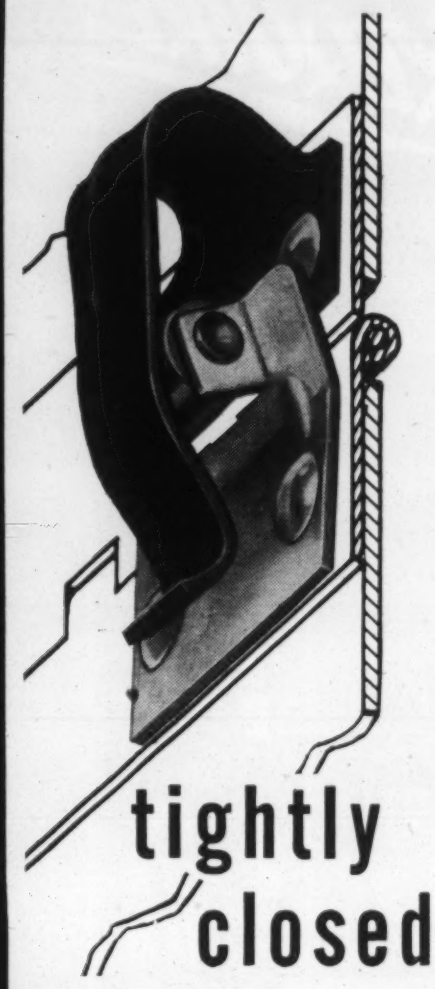
American Brake Shoe Co.	Mahwah, New Jersey
The American Laundry Machinery Co.	Rochester, New York
Atlas Foundry Co.	Detroit, Michigan
Banner Iron Works	St. Louis, Missouri
Barnett Foundry & Machine Co.	Irvington, New Jersey
E. W. Bliss Co.	Hastings, Mich. and Toledo, O.
Builders Iron Foundry	Providence, Rhode Island
Continental Gin Co.	Birmingham, Alabama
Crawford & Doherty Foundry Co.	Portland, Oregon
The Cooper-Bessemer Corp.	Mt. Vernon, Ohio and Grove City, Pa.
Farrel-Birmingham Co., Inc.	Ansonia, Connecticut
Florence Pipe Foundry & Machine Co.	Florence, New Jersey
Fulton Foundry & Machine Co., Inc.	Cleveland, Ohio
General Foundry & Manufacturing Co.	Flint, Michigan
Greenlee Foundry Co.	Chicago, Illinois
The Hamilton Foundry & Machine Co.	Hamilton, Ohio
Johnstone Foundries, Inc.	Grove City, Pennsylvania
Kanawha Manufacturing Co.	Charleston, West Virginia
Lincoln Foundry Corp.	Los Angeles, California
E. Long Ltd.	Orillia, Ontario
Otis Elevator Co., Ltd.	Hamilton, Ontario
The Henry Perkins Co.	Bridgewater, Massachusetts
Pohlman Foundry Co., Inc.	Buffalo, New York
Rosedale Foundry & Machine Co.	Pittsburgh, Pennsylvania
Ross-Meehan Foundries	Chattanooga, Tennessee
Shenango-Penn Mold Co.	Dover, Ohio
Standard Foundry Co.	Worcester, Massachusetts
The Stearns-Roger Manufacturing Co.	Denver, Colorado
Traylor Engineering & Mfg. Co.	Allentown, Pennsylvania
Valley Iron Works, Inc.	St. Paul, Minnesota
Vulcan Foundry Co.	Oakland, California
Warren Foundry & Pipe Corporation	Phillipsburg, New Jersey

"This advertisement sponsored by foundries listed above."

NEW ROCHELLE, N. Y.

HOLD HINGED DOORS

firmly open



tightly closed

with a RUGGED spring

For frequently used doors and panels, SOUTHCO Retaining Springs with a new smooth-action roller-bearing surface provide time-saving convenience and trouble-free long life. They hold doors firmly open, so that both hands are free to work, and they hold doors tightly closed to eliminate vibration, rattle and dirt.

Several styles are available for a variety of spring tensions and door positions. Write for the whole story. SOUTHCO Div., South Chester Corporation, 1404 Finance Bldg., Philadelphia 2, Pa.

SOUTHCO

DOOR RETAINING SPRINGS

New Materials and Equipment

with use of special alloy lead Type "S."

2. Open construction makes higher current densities possible due to better circulation of solution and increased anode surface exposure.
3. Decreased weight of anodes facilitates easier handling.

These anodes can be furnished in 6% antimony lead, 7% tin lead, or any other commonly used alloy.

4. Better covering power is offered, especially on difficult parts to plate due to wider current density range.

According to the manufacturer, it is best to keep the current turned on at all times when the anodes are in the bath. Anodes should be removed, rinsed and stored in air when the tank is idle.

Barrel Finishing Compounds

Almco Supersheen, Albert Lea, Minn., has announced the development of three new barrel finishing compounds.

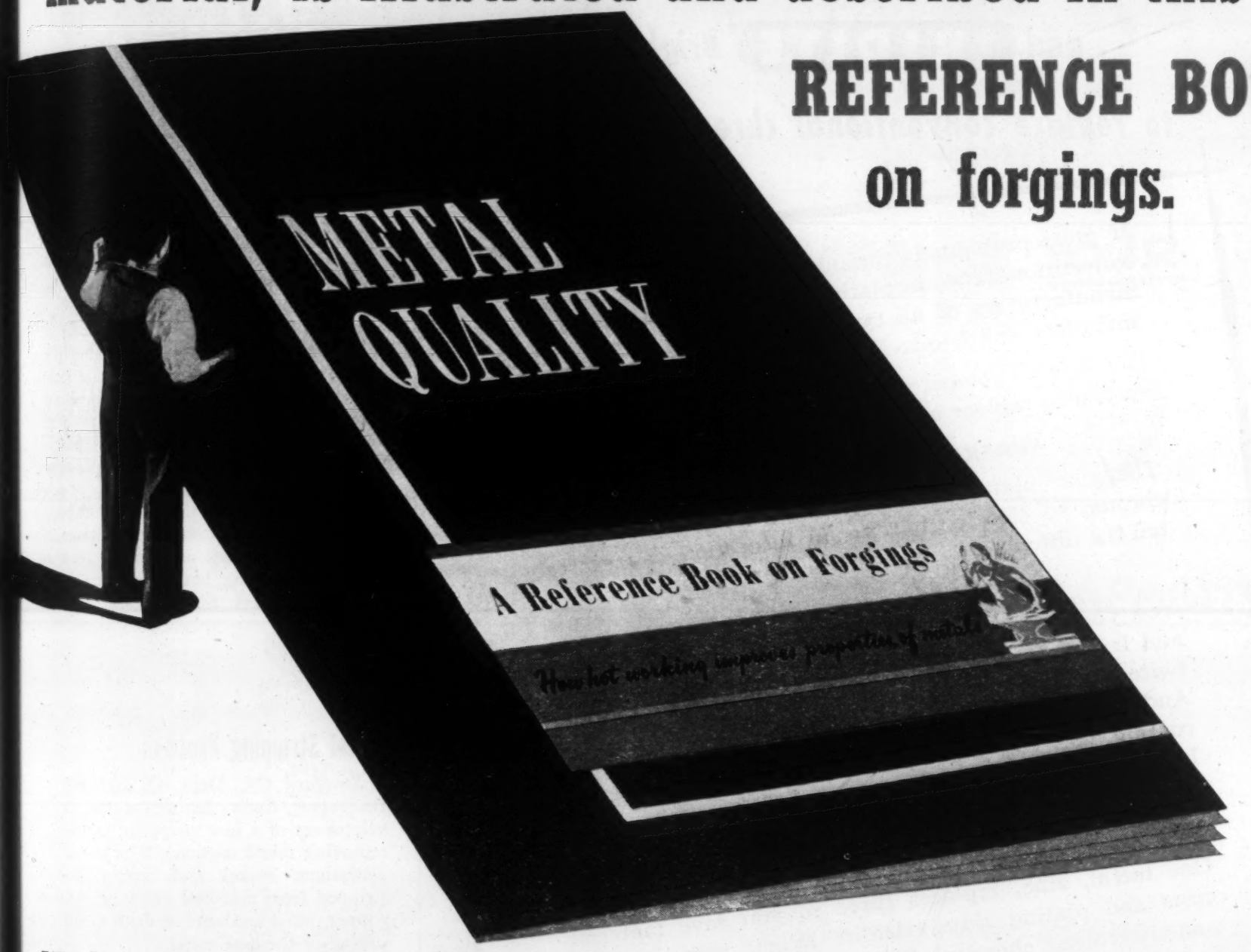
The first of the three, Abrasive Compound No. 3, which is recommended for use in self-tumbling and with the various abrasive chips, contains a very aggressive abrasive and can be used with water. It is said to be a replacement for the old emery and oil method of tumbling. Advantages claimed for No. 3 compound are fast cutting down, free rinsing, oxidation inhibition, improved color, rust prevention, and unusually low processing costs.

Coloring and Burnishing Compound No. 10 is especially designed to produce

What *Forgings* have that offer so many more economic, engineering and production advantages than can be obtained with any other material, is illustrated and described in this

REFERENCE BOOK

on forgings.



Write for a copy. Then consult a forging engineer about how you can obtain the correct combination of mechanical qualities in forgings for your particular type of equipment.

DROP FORGING ASSOCIATION
605 HANNA BUILDING • CLEVELAND 15, OHIO

DROP FORGING ASSOCIATION • 605 Hanna Building • Cleveland 15, Ohio

Please send 60-page booklet entitled "Metal Quality—How Hot Working Improves Properties of Metals", 1949 edition.

Name..... Position.....

Company.....

Address.....

BRIGHT FINISHING SYSTEM

SPARKLES

LIKE CHROME!

Leading manufacturers approve zinc plate

and IRIDITE® Bright

to replace conventional chrome plating

If your problem is finding the right finish to replace conventional chrome plating, follow the lead of prominent manufacturers of all types of products . . . switch to zinc plate and Iridite Bright.

Here's what you get when you use this chromate finishing system to replace conventional chrome plating.

SPARKLING BRIGHT APPEARANCE

The zinc plate and Iridite Bright system resembles chrome so closely that visual inspection can scarcely tell the difference! And, the brilliance *lasts*.

BETTER CORROSION PROTECTION

Yes, you actually get better protection with zinc plate and Iridite Bright than with chrome plating . . . up to twice the life under accelerated salt spray conditions! And, by applying a clear baking lacquer over the Iridite coating you can increase the abrasion resistance and lasting qualities of this bright finishing system, at the same time making possible a greater salt spray protection.

LOWER FINISHING COSTS

One metal, zinc, replaces three so you save material costs and plating time. Iridite Bright goes on in a non-electrolytic chemical dip.

Write or call today for your copy of our new Technical Bulletin describing all phases of this bright finishing system in detail. Tell us your bright finishing requirements. If possible send sample parts for test processing.

Iridite is approved under government specifications

ALLIED RESEARCH PRODUCTS
INCORPORATED
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REPRESENTATIVES IN PRINCIPAL INDUSTRIAL CITIES; West Coast: L. H. BUTCHER COMPANY
Manufacturers of Iridite Finishes
for Corrosion Resistance and Paint Systems on Non-Ferrous Metals; ARP Plating Chemicals.

New Materials and Equipment

better burnished finishes. Said to prevent discoloration of work due to compound breakdown, the compound is claimed to produce a clean, free-rinsing surface with no fatty soap deposits. No. 10 contains ample water softeners requiring no separate additives under hard water conditions, and prevents loading of chips or work with hard water precipitates or soil. A special advantage claimed for this compound is that aluminum and stainless steel colors are protected during deburring and grinding cycles.

Descaling Compound No. 15, the third compound, is slightly acid and has been intended especially for applications requiring quick descaling of steel parts. A great advantage offered by No. 15 is that it descales, deburs and polishes simultaneously when used in combination with abrasive chips. Under actual operation, it is said to be possible to replace an acid pickling operation, a sandblasting operation, and quite often, a grinding, burnishing or coloring operation with this new compound. Effective with either cold or hot water, No. 15 leaves the work and chips clean and ready for grinding, burnishing or coloring, as required.

Metal Stripping Process

Stratford Co., Dept. Q, 207 Bay St., Bridgeport, Conn., has announced the development of a new stripping process for removing metal coatings. It is stated that chromium, nickel and copper can be stripped from zinc-base alloys, aluminum, copper, brass and steel without etching or pitting of the base metal.

Zinc die castings are said to be stripped cleanly in order that they can be rebuffed to a high luster by means of only a wheel wipe.

Welding & Joining

Electrode Conservation Process

A program for the conservation of spot welding electrodes has been developed by *P. R. Mallory & Co., Inc.*, Indianapolis, Ind., as a means of conserving copper.

The Nu-Tip process, consisting of braz-

SPEED UP PRODUCTION

but DON'T GAMBLE WITH QUALITY

Lepel

HIGH FREQUENCY *Induction* HEATING UNITS

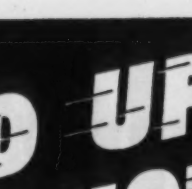
INSURE uniform high speed quality production with measured, controlled heat exactly where required for exactly as long as required.

YOU CAN DO ALL THESE JOBS

faster better cheaper with any

LEPEL High Frequency HEATING UNIT

HARDENING
Heat localized exactly where wanted, to any desired temperature up to 5000° F



BRAZING
Permits widest choice of copper or silver brazing alloys

MELTING
Readily melts metals and alloys of high melting point

SOLDERING
Neater, faster, without waste or discoloration.

ANNEALING
STRESS RELIEVING
NORMALIZING
PRE-HEATING
For Hot Forging, Hot Drawing, etc.

LEPEL Electronic Tube GENERATORS from 1 kw to 50 kw

LEPEL Spark Gap CONVERTERS from 2 kw to 30 kw

Lepel engineers in the field and in our fully equipped laboratories will be happy to assist you with your own heating operations. Send samples and specifications of your work for free processing and recommendations.

LEPEL HIGH FREQUENCY LABORATORIES, Inc.,
39 West 60th Street — New York 23, N. Y.

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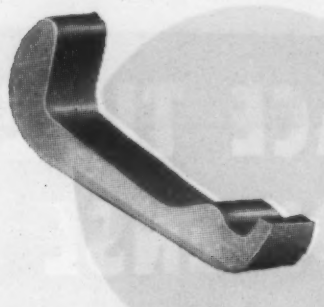
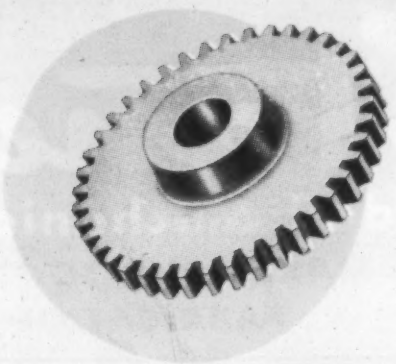
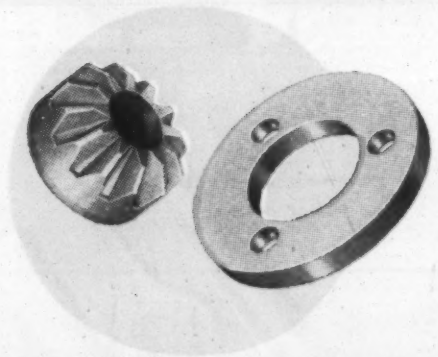


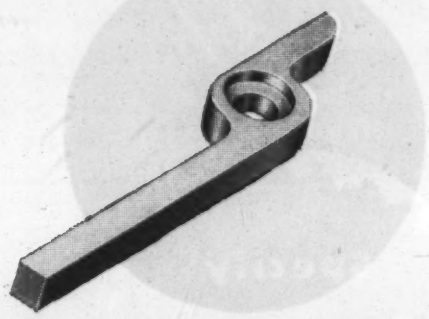
POWDERMET* PARTS



INCREASE YOUR

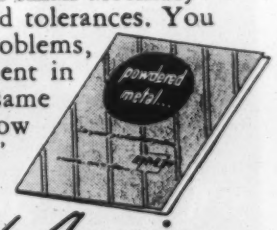


PRODUCTION CAPACITY



PRECISION PARTS ARE DELIVERED READY FOR ASSEMBLY WITHOUT FURTHER PROCESSING!

Gears, bearings, electronic components and small assembly parts are fabricated to your specifications and tolerances. You avoid troublesome raw material procurement problems, decrease the burden on over loaded equipment in your own plant and reduce costs at the same time. Send for this free booklet today and see how "Powdered Metal In Your Production Picture" will increase your output!



POWDERED METAL PRODUCTS CORPORATION *of America*
9335 West Belmont Avenue, Franklin Park, Illinois

PMP

*Trade Mark

PEACE TIME
DEFENSE TIME
EVERY TIME

"Standard's"

Welded Mechanical Steel Tubing

MAKES THE TOUGHEST TUBING FABRICATION POSSIBLE

If you need the best tubing for civilian or defense purposes, "Standard's" Mechanical Steel Tubing can really "take it".

Automobile manufacturers too, know "Standard" welded tubing safely stands the severest tubular applications. This is proven in the automobile propeller shaft that operates safely and dependably at high R.P.M.'s day in and day out.

Peace time, defense time, every time—"Standard's" modern facilities, and 25 years of tubing know-how, assure you the highest quality tubing available.

Specify "Standard" —IT PAYS!

THE STANDARD TUBE CO.
Detroit 28, Michigan
Welded Tubing
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STANDARDIZE with "STANDARD" — It Pays

CARBON STEEL TUBING
½" O.D. to 5½" O.D.
.028 to .260 wall

STAINLESS STEEL TUBING
⅜" O.D. to 3" O.D.
.028 to .095 wall

New Materials and Equipment

ing onto a used electrode shank a new nose of the same class of material, employs a special Mallory silver solder which is said to provide a bond of high melting point, high strength and low electrical resistance. Loss of electrode hardness is claimed to be held within an unusually low limit.

According to the company, Nu-Tip electrodes have run 30,000 welds and have withstood repeated applications of 2,000 lb of force at an angle of 30 degrees.

Although the new electrode is not expected to be the equivalent of a new unit, it has been found that the method does provide substantial service life for electrodes that would otherwise be scrapped.

Magnesium Welding Rod

Intended for the filling of holes in magnesium castings, building up, or repairing cracks and general salvage, and for repair and maintenance work on cast magnesium, the new magnesium rod offered by *All-State Welding Alloys Co., Inc.*, 273 Ferris Ave., White Plains, N. Y., is said to give not only the same strength and corrosion resistant properties of the base metal, but also to melt well below the melting point of the casting in order not to damage it.

Though developed for application with Heliarc or corresponding process, All-State No. 61 can be applied by torch brazing if used with No. 61 Brazaloy flux. Normal aluminum brazing technique is suitable, and the flux residue must be removed immediately after the brazing operation to avoid subsequent corrosion.

Free-flowing, with a working temperature of 1090 F, the rod is said to be applicable for all types of cast and wrought magnesium except Type AM-403. It can also be used to join magnesium sheet.

Adequate stocks of 3/16-in. dia by 18-in. lengths are available. The 5/32-in. dia, however, is in short supply and can be obtained only on defense orders.

Brazing and Soldering Rings

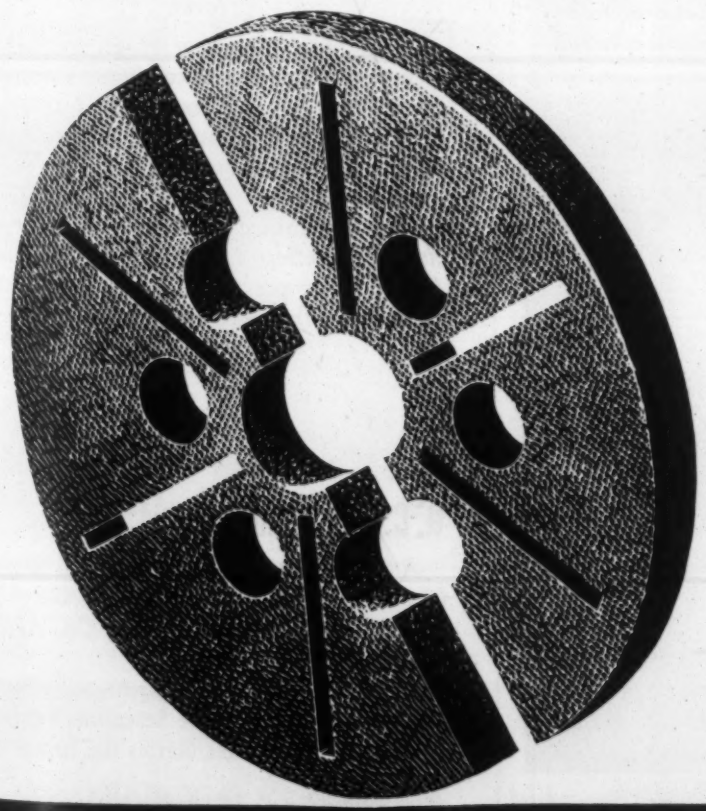
Flat wire, stress-relieved silver brazing and soldering rings for faster, more economical and improved brazing of Armed Forces projectiles and other ordnance equipment are now available from *Lucas-Milhaupt Engineering Co.*, 5051 S. Lake Dr., Cudahy, Wis.

These flat wire preforms are designed especially for applications requiring larger

P.V.* APPROVAL

*Plus Value

Western Felt users over a long period of years have placed their stamp of approval on a long list of its products. They know from experience the "plus value" in every Western Felt component part. Highest precision in its processing and cutting produces a uniformity that minimizes rejections—prevents failure of the finished product from felt causes. They are available from wool softness to rock hardness—never lose shape—do not ravel or fray—resist oil, water, age—are resilient, flexible, compressible—may be cut to close tolerances.



WESTERN Felt WORKS

4035-4117 Ogden Ave., Chicago 23, Illinois

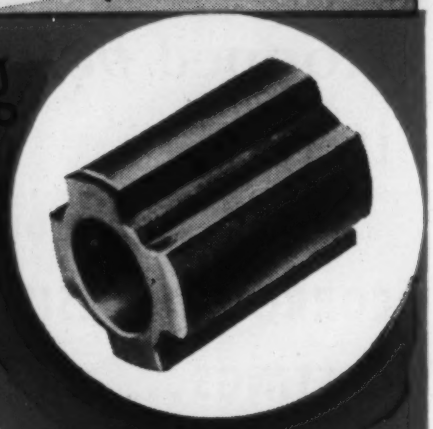
Branch Offices in Principal Cities

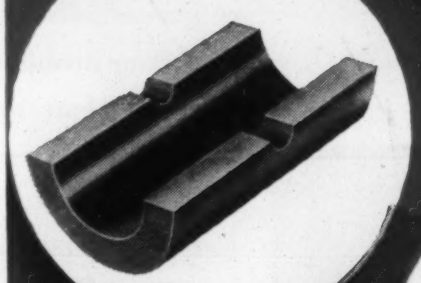
Manufacturers and Cutters of Wool Felts

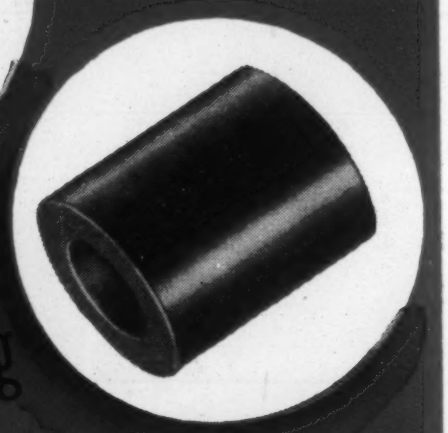
Acadia Synthetic Products Division, WESTERN FELT WORKS, Processors of Synthetic Rubbers — Sheets, Extrusions, Molded Parts.

Here's the answer to your BEARING problems

Non-contaminating
Non-warping







Long-lasting
Self-lubricating

MORGANITE

– recommended for dye vats, immersion rolls and general textile service

Operates efficiently in all dyes and bleaches with out ill effect to bearing or the liquids. The self-lubricating quality of the bearing is inherent in the material — no oil impregnation is used and the bearing never needs lubrication. Morganite Bearing and other carbon parts are non-warping, impart no taste or odor, are unaffected by, and will not contaminate, chemical solutions. Being self-lapping and polishing, they offer long-lasting high speed, high pressure service.

see our CATALOG in SWEET'S FILE for PRODUCT DESIGNERS

INVESTIGATE THE ADVANTAGES of Morganite, now! Call or write for complete engineering data on Morganite self-lubricating carbon specialties, or consult our catalog in Sweet's File for Product Designers.

REGISTERED TRADE MARK Morganite

INCORPORATED

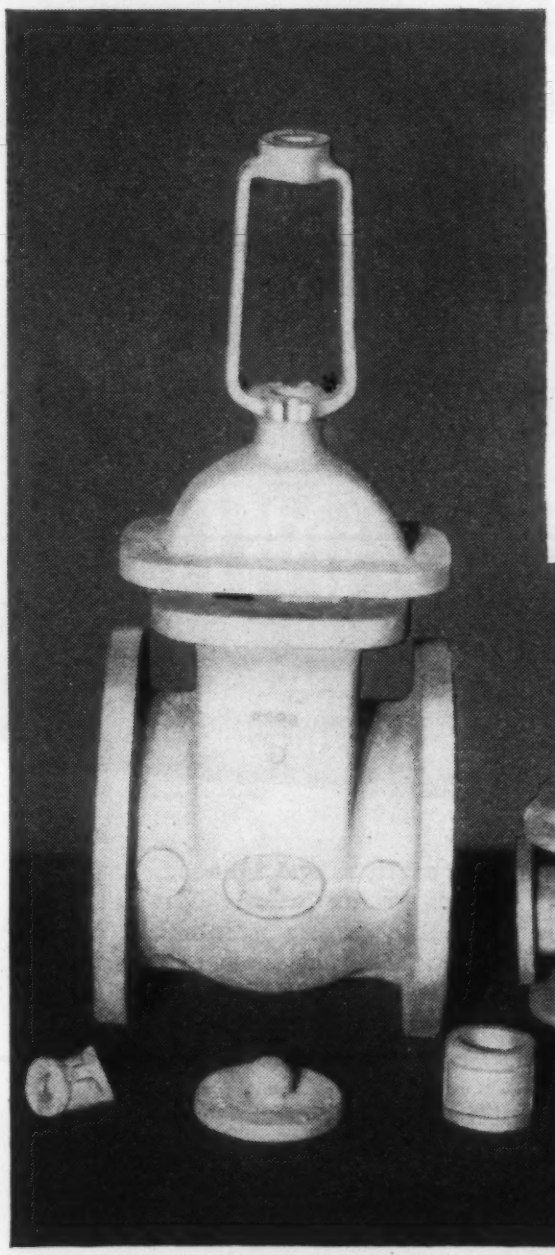
LONG ISLAND CITY 1, NEW YORK

Manufacturers of CARBON MOTOR and GENERATOR BRUSHES, CARBON PILES and SELF-LUBRICATING CARBON SPECIALTIES

CORROSION

stopped *before* it starts

with Lebanon CORROSION-RESISTANT CASTINGS...



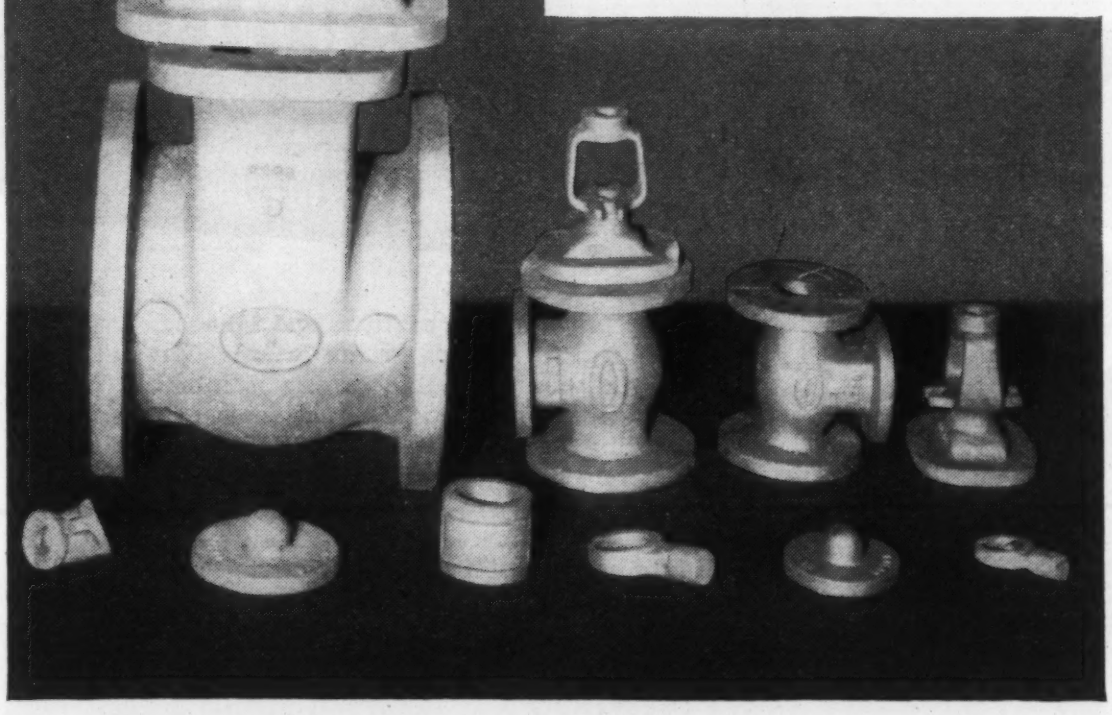
Stopping that metal-eating "glutton"—corrosion, before he even gets started, is something we've had a hand in doing for many years.

Stainless castings produced by Lebanon's exclusive processes have the *right* composition, the *right* uniformity and the *right* internal integrity to keep corrosion from taking its toll. Our twenty years of experience in developing and producing castings that are resistant to many corrosive agents, mean that we can accurately anticipate your needs.

If your problem is corrosion, bring that problem to our engineers... they'll help you defeat this enemy before he has a chance to start. Lebanon REFERENCE CHARTS give complete information on the types of material available... write for your copies today.

LEBANON STEEL FOUNDRY
Lebanon, Pennsylvania
"In the Lebanon Valley"

Valve Bodies and Fittings are typical of the types of castings made by Lebanon to be used in services where corrosion is a factor.



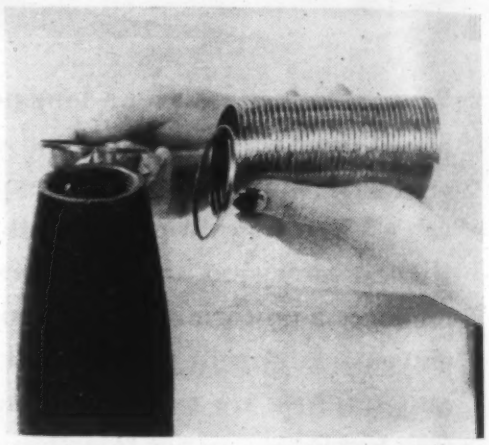
LEBANON ALLOY AND STEEL **Castings**

CIRCLE L

New Materials and Equipment

volume of silver alloy for added strength in critical joints and where the depth and shape of the groove prohibit use of round wire rings.

Flat wire rings can be made in unlimited, job-determined diameters and wire thicknesses in butt, lap and gap form. Because they are flattened to individual job



These flat wire brazing and soldering rings can be made in job-determined diameters and wire thicknesses in butt, lap and gap form.

specifications, the new rings are said to provide a more complete fill and a stronger, leak-proof bond. Stress-relieved rings retain a plus and minus 0.001-in. tolerance under all conditions and do not distort under heat.

Job determined dimensions of the rings are said to effect a 45% saving in precious alloys, while precise fabrication eliminates rejects and the need for machining brazed parts.

D. C. Arc Welder

A new d.c. welder which is said to possess a.c. advantages has been announced by *Miller Electric Manufacturing Co.*, Appleton, Wis.

Available in two models, 40- to 250-amp and 60- to 375-amp, the Selenium Rectifier Type D.C. arc welder claims the following features:

1. Exclusive arc start surge.
2. Electric current control, which makes possible remote control operation.
3. No moving parts to wear out.
4. No replacement stock, such as brushes, bearings, etc.
5. No accidental polarity reversal.

Compact in design, this welder requires less floor space than most d.c. welders of comparable capacity. In applications where

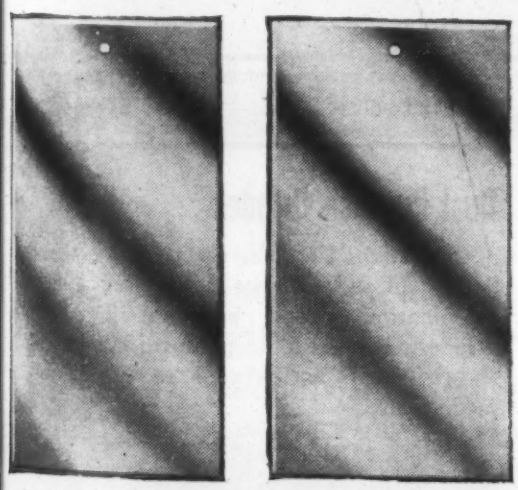
New Materials and Equipment

Clear Coatings for Zinc and Steel Stand 800 Hours' Salt Spray

Increased use of zinc die castings and of zinc-plated steel to replace unavailable materials, combined with the tight supply of copper, nickel and chromium normally used for plating zinc, has focused attention on surface coatings comparable to plating in service performance. Unbiased laboratory tests show that at least two of the clear finishes in the company's line withstand the exceptionally long period of 800 hours' exposure to salt spray and to weatherometer tests.

Effectively protect zinc

These tests demonstrate that DULAC Clear Universal Lacquer #462 and CODUR Clear Synthetic Y743 provide completely satisfactory protection on zinc, zinc plated steel and steel. Even after the unusually severe tests to which these finishes were subjected, there was no indication whatever either of failure of the coating or of discoloration of the zinc.



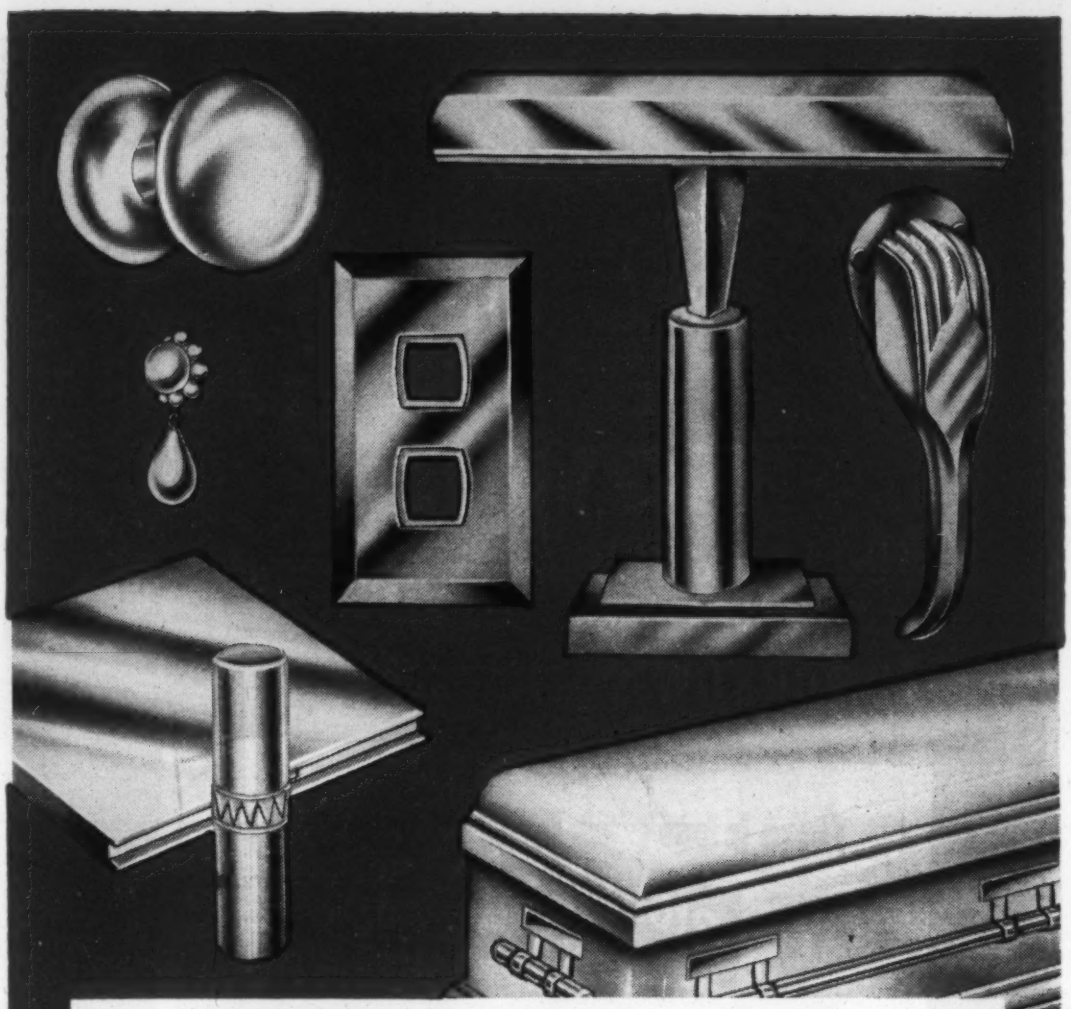
(Left) A zinc-plated steel panel newly coated with DULAC #462. (Right) A similar panel after 800 hours' exposure to salt spray, showing no evidence of attack on on the finish.

Adaptability to Drying Schedules

While both finishes give the same performance, DULAC #462 is an air-drying coating, while CODUR Y743 is a baking type. This permits choice of the correct finish to fit into the drying schedules of a particular finishing room.

Technical Data Bulletin #110 on clear finishes is available from Maas & Waldstein Co., 430 Riverside Avenue, Newark 4, N. J. On request, M & W Technical Service Engineers will discuss specific problems.

(Adv.)



NOW! simulate copper, brass and bronze on products like these with

M&W PLATELUSTRE

● Don't let critical metals put a *needless* crimp in your production!

Take zinc or steel—apply a coating of one of the new PLATELUSTRE finishes. You wind up with products and parts that look so much like copper, brass and bronze that *the eye can scarcely tell the difference!*

Whether you have been using now unavailable copper and its alloys for *making* products or for *plating* products, you will find these new M & W finishes *equally* effective in keeping your plant running. There are types for air-drying and baking schedules — pick the one that best fits *your* production requirements.

Let an M & W Technical Service Engineer show you—*right in your own plant*—how easy these PLATELUSTRE coatings are to use, and what striking effects they produce. Or, if you prefer, write for free literature.

PIONEERS IN PROTECTION

75th ANNIVERSARY • M&W CO. 1876

MAAS & WALDSTEIN CO. 438 RIVERSIDE AVE. NEWARK 4, N. J.

MID-WEST DIV.-1658 CARROLL AVE., CHICAGO 12, ILLINOIS

PACIFIC COAST DIV.-SMITH-DAVIS CO., 10751 VENICE BLVD., LOS ANGELES 34, CAL.

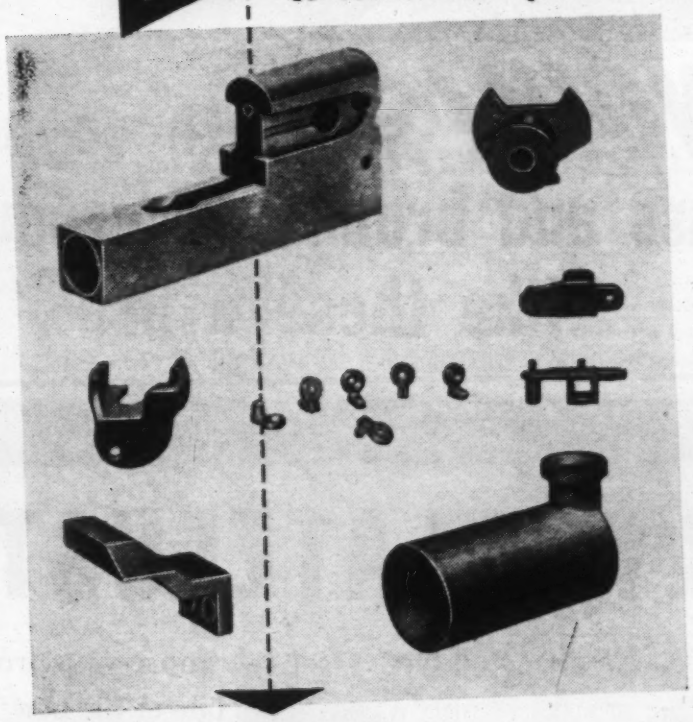
MANUFACTURERS OF INDUSTRIAL FINISHES

Learn about

PRECISION INVESTMENT CASTINGS NOW...

TODAY you may not need them, but who knows what TOMORROW'S needs will be

There is one RIGHT WAY to form these parts...



HITCHINER
PRECISION INVESTMENT CASTINGS

GET THIS BULLETIN FREE

It gives general, technical and design data.
Be ready with a complete knowledge of the possibilities — and the limitations — of precision investment castings when the need arises.

Answers to specific questions will be given gladly and without obligation if you send us complete details and prints.

HITCHINER MANUFACTURING COMPANY, INC.

MANCHESTER, NEW HAMPSHIRE

Representatives in all principal cities

New Materials and Equipment

it is required, the unit is said to be used effectively for inert gas welding processes.

Welding Electrode

Development of a new welding electrode, the DH-4, which is said to feature time-saving penetration and solid fusion, has been introduced by *Harnischfeger Corp.*, Milwaukee 14, Wis.

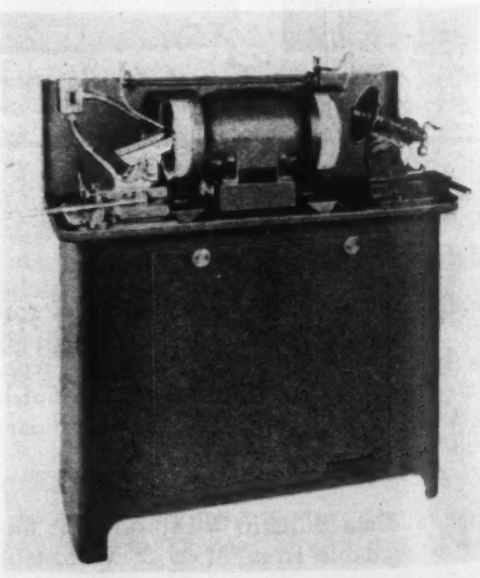
Applications of the a.c., d.c. electrode include: quick and inexpensive welding of extremely heavy sections; fast, easy making of horizontal fillet welds; gouging removal of cracked and faulty welds; safe cutting of stainless steel, mild steel, manganese, bronze, aluminum and cast iron.

The electrode is produced in three sizes: 1/8 in. for use at 300 amp, 5/32 in. for use at 400 amp, and 3/16 in. for use at 450 to 500 amp.

Forming & Machining

Dual Purpose Grinder

Continental Machine Co., 1952 N. Maud Ave., Chicago 14, has announced a new combination chaser and cut-off wheel grinder designed to keep cut-off blades and chasers sharp and always ready for immediate use.

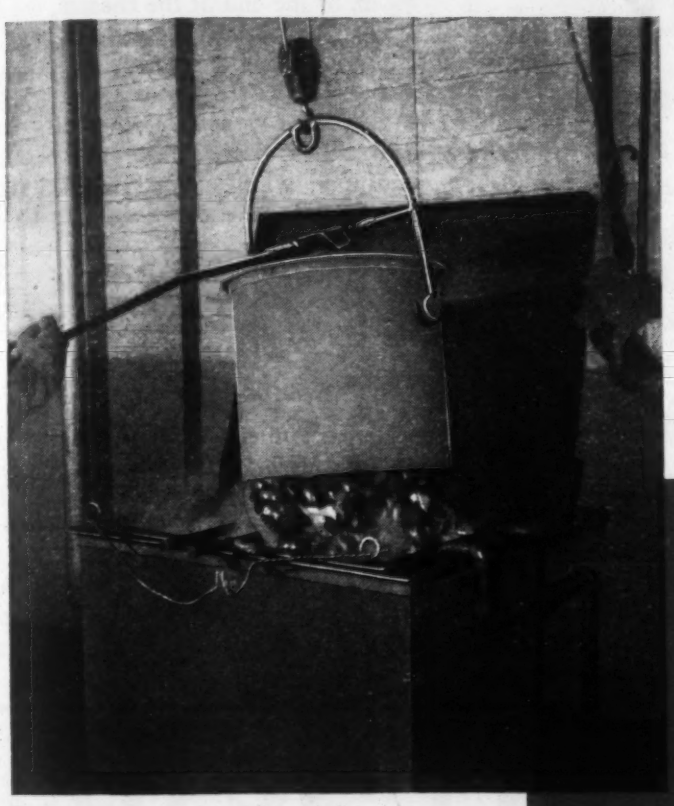


This combination chaser and cut-off wheel grinder is said to convert dull cut-off blades into production-boosting tools in a matter of minutes.

ROLOCK

HEAT AND CORROSION RESISTANT

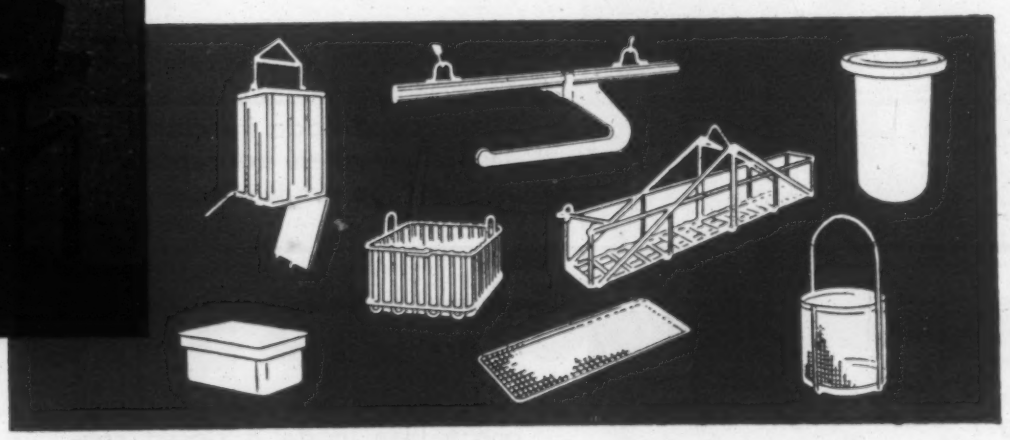
FABRICATED ALLOYS



$aving

CASE HISTORY NO. 2

Photo shows installation at the Bassick Co., Bridgeport, Conn., of a Rolock alloy Drop-Bottom Basket used with a pit-type furnace.



Rolock developed this fabricated drop-bottom basket for 2 reasons... to produce better work... to lengthen basket life, with consequent work-hour cost reduction.

Records show uniform heating with practically no rejects. Because the basket cover is closed and work is spilled out at bottom, distortion of parts and scratching are minimized. Draw pin is pulled for quench so that there's little exposure of work to cold air between heat and quench... then basket is reloaded fast and returned to furnace, retaining heat, increasing furnace capacity. Basket is not quenched with work... severe thermal shock is eliminated.

Such fabricated-welded baskets may be engineered to your job... fitted to your furnace. They give you highest resistance to cracked ammonia and carburizing atmospheres...handle greater load ratio to basket weight. Look to Rolock for greater dollar savings, better work in heat treating. Send for Catalog.

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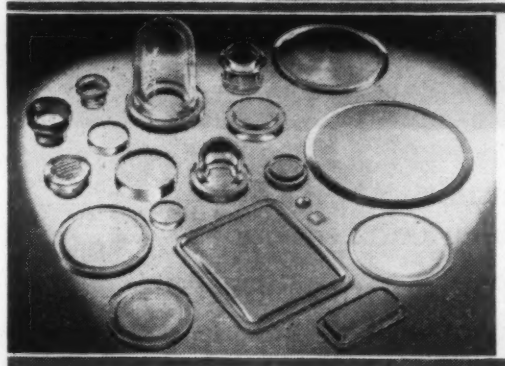
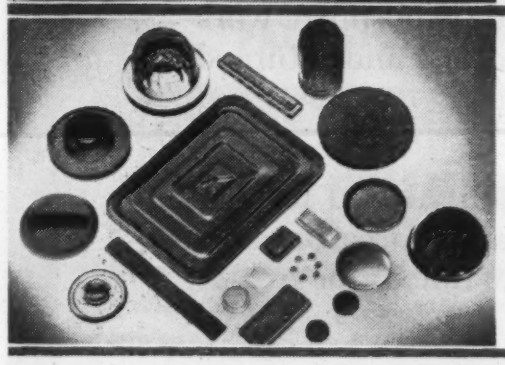
Kopp engineers will help you make full use of the beauty and durability of glass to improve the sales appeal and performance of your products.

Glass is colorful, beautiful, strong, wear-resistant; it won't rot, rust, warp or stain; it is sanitary and easily cleaned. We will be glad to help you employ these advantages in your products.

Skillful design and careful workmanship are needed to produce the precision-made, intricate lenses shown here. These are representative of Kopp production.



Sight glasses are used to permit one to see inside a closed container or other vessel. Such items form an important part of Kopp production.



Color, accurate shape and size and dependable uniformity are properties demanded of Indicator glasses. Kopp makes many types and sizes—from tiny indicator buttons to panels with integral lenses and prisms.

KOPP GLASS

KOPP GLASS, Inc.

SWISSVALE, PA.

New Materials and Equipment

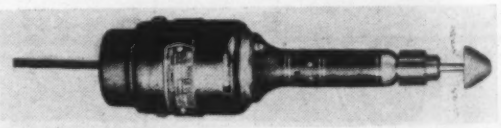
The left hand side of the machine is designed to sharpen chasers for threading up to 8-in. pipe, while pipe and tube cut-off blades are sharpened on the right hand side. Said to lengthen the life of chasers, permitting repeated sharpenings down to within 1/2-in. of the end of the chasers, the mechanism is adjustable for any angle of bevel, and true blade diameter is retained even after repeated sharpenings.

Powered by a 1½-hp totally enclosed 220/440 v, 3-phase motor, the grinder is equipped with a 12-gal capacity coolant system to prevent overheating of tools.

Hand Grinder

Recently introduced by *Chicago Wheel & Manufacturing Co.*, 1101 W. Monroe St., Chicago, a new powered hand tool, the Hi-Power Grinder, is designed for heavy production work.

Said to feature more engineering advances than any other tool of its type, the grinder is ideal for industrial plants, pattern shops, foundries, die shops and other places, under a wide variety of conditions. Designed for constant duty without slowdown, the hand tool has the power, speed and stamina to do everything from delicate die jobs to hogging off substantial amounts of stock.



This high power grinder operates at 20,000 rpm.

Equipped with eight accessories, including mounted wheels, sander, chuck key and dressing stone, the grinder is available in two models: No. 3500—110- to 120-v a.c. or d.c., 25 to 60 cycle; and No. 3505—220-v a.c. or d.c., 25 to 60 cycle.

Testing & Control

Direct-Reading Spectrometer

A direct-reading spectrometer designed for almost instantaneous analysis of metals has been announced by *Applied Research*

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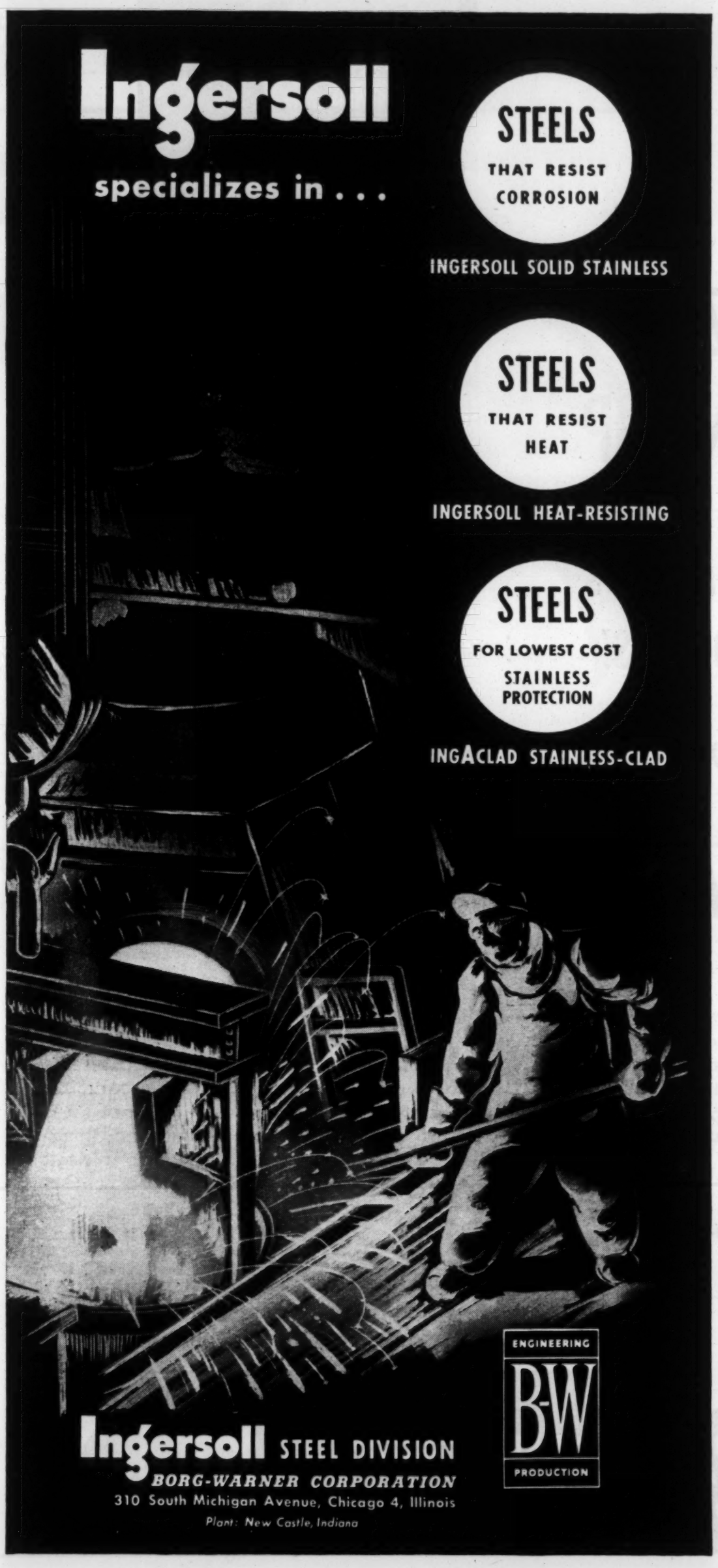

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BORG-WARNER CORPORATION

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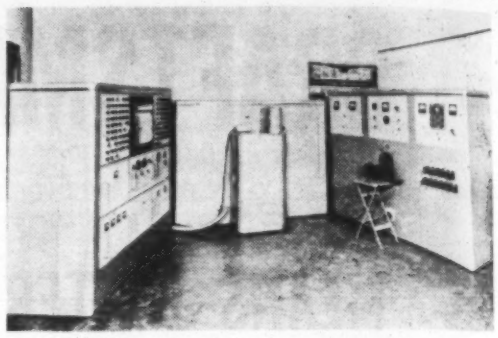
Plant: New Castle, Indiana

ENGINEERING B-W PRODUCTION

New Materials and Equipment

Laboratories, 4336 San Fernando Rd., Glendale 4, Calif.

Applicable to a wide variety of metals, including stainless steel and similar metals and inorganic materials, the unit is based on spectroscopic principles and embodies



This direct-reading spectrometer is designed for almost instantaneous analysis of metals.

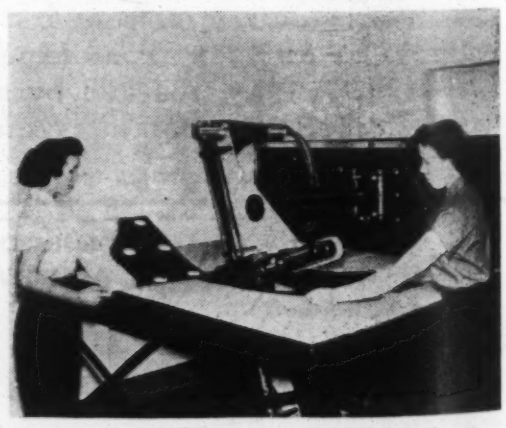
the additional feature of providing pen and ink recorded analyses of samples, element by element, within a period of 2 min. or less.

According to the manufacturer, the recording mechanism can produce multiple copies of these records for high-speed analytical control when desired.

Testing Device for Tin

United States Steel Corp., 208 S. La Salle St., Chicago 90, has announced an automatic testing device designed to save scarce steel.

Combining the use of Geiger counters



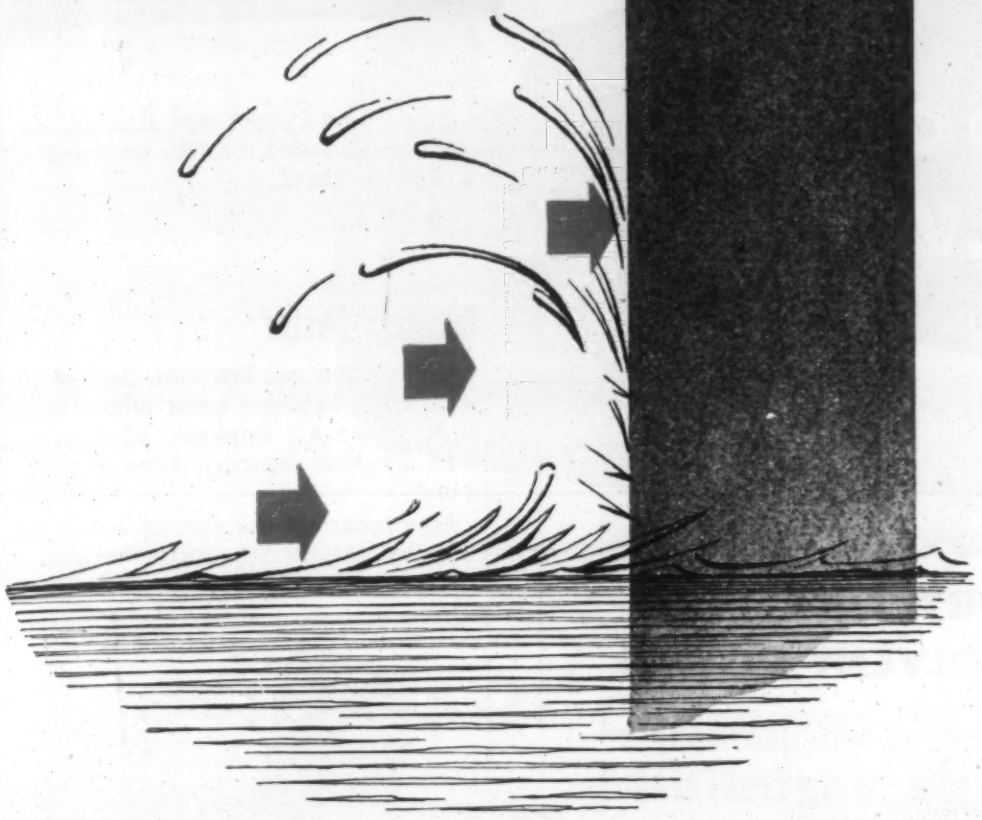
Here tin plate is placed under the automatic x-ray machine, which uses a Geiger counter to test uniformity of tin coating.

and x-rays, the new instrument measures x-rays reflected from the steel sheet to determine the thickness of the tin coating.

In design, the machine consists of two x-ray tubes, one mounted above the test sheet and the other below. The strength of the reflected x-ray beams from the sheet are measured by Geiger counters and the count

Where EROSION is a problem . . .

GUN IRON CASTINGS



The hardness and dense, close-grained structure of Gun Iron is ideally suited to give long resistance to erosion or corrosion. When required, this resistance can be further increased by heat treatment and/or proper alloys.

Gun Iron has been used to combat casting erosion on a number of widely varied applications. A typical example is in the case of main cylinder liners in marine diesel engines. Where the coolant water is drawn directly from the sea, the chemical impurities cavitate the liners to the point where they are useless long before they are worn out. Gun Iron liners satisfactorily withstand this erosion and at the same time give longer wear on the cylinder wall. The savings in maintenance and replacement costs reported by users are tremendous.

Gun Iron also provides exceptional resistance to prolonged heats, impact and pressure. The proof of Gun Iron's superiority when used for parts subjected to these problems has been dramatically illustrated thousands of times in the last 139 years. To help determine the specific value of Gun Iron for *your* strategic cast parts, our engineers and complete laboratory facilities are at your disposal. Our furnaces, foundry and extensive machining facilities stand ready to produce them accurately and economically.

Where can *You* use GUN IRON to advantage?

During the past 140 years, Gun Iron and its alloys have proved superior on hundreds of applications in almost as many fields. A few general applications are listed here:

CYLINDER LINERS • DIESEL HEADS • RINGS • PRESSURE TIGHT CASTINGS • DIES • CASTINGS FOR ALL TYPES OF MACHINERY • PARTS FOR PUMPS, COMPRESSORS, ENGINES, ETC. • SURFACE PLATES • LOCOMOTIVE CYLINDER AND VALVE BUSHINGS AND OTHER FRICTIONAL WEARING PARTS

Chances are that there are many other places where Gun Iron can solve a design or operating problem. To help you determine the value of Gun Iron for your cast parts, our metallurgical department has prepared a comprehensive bulletin which contains complete properties and discussions of Gun Iron and many other metals. Engineers claim it an invaluable reference aid. Send for your free copy today.

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TOLEDO—WESTERN SOLVENTS, Central & Reynolds Rd.....Jordon 0761

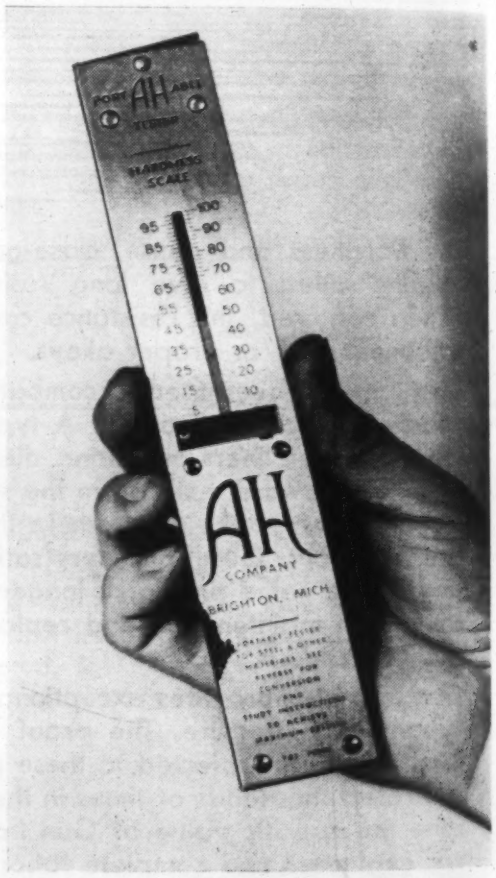
New Materials and Equipment

is recorded on a paper tape. Recorded readings are calculated into the amount of tin on the test sheet.

Hardness Tester

Lightweight and low cost, the new precision-made hardness tester offered by the *A. H. Company,* Brighton, Mich., is said to be a radical departure from testers now in use.

Approximately the size of a slide rule (8¾ by 1½ by ½ in.), the tester is claimed to be an accurate means for obtaining consistently accurate hardness readings based on the surface elasticity of the objects tested.

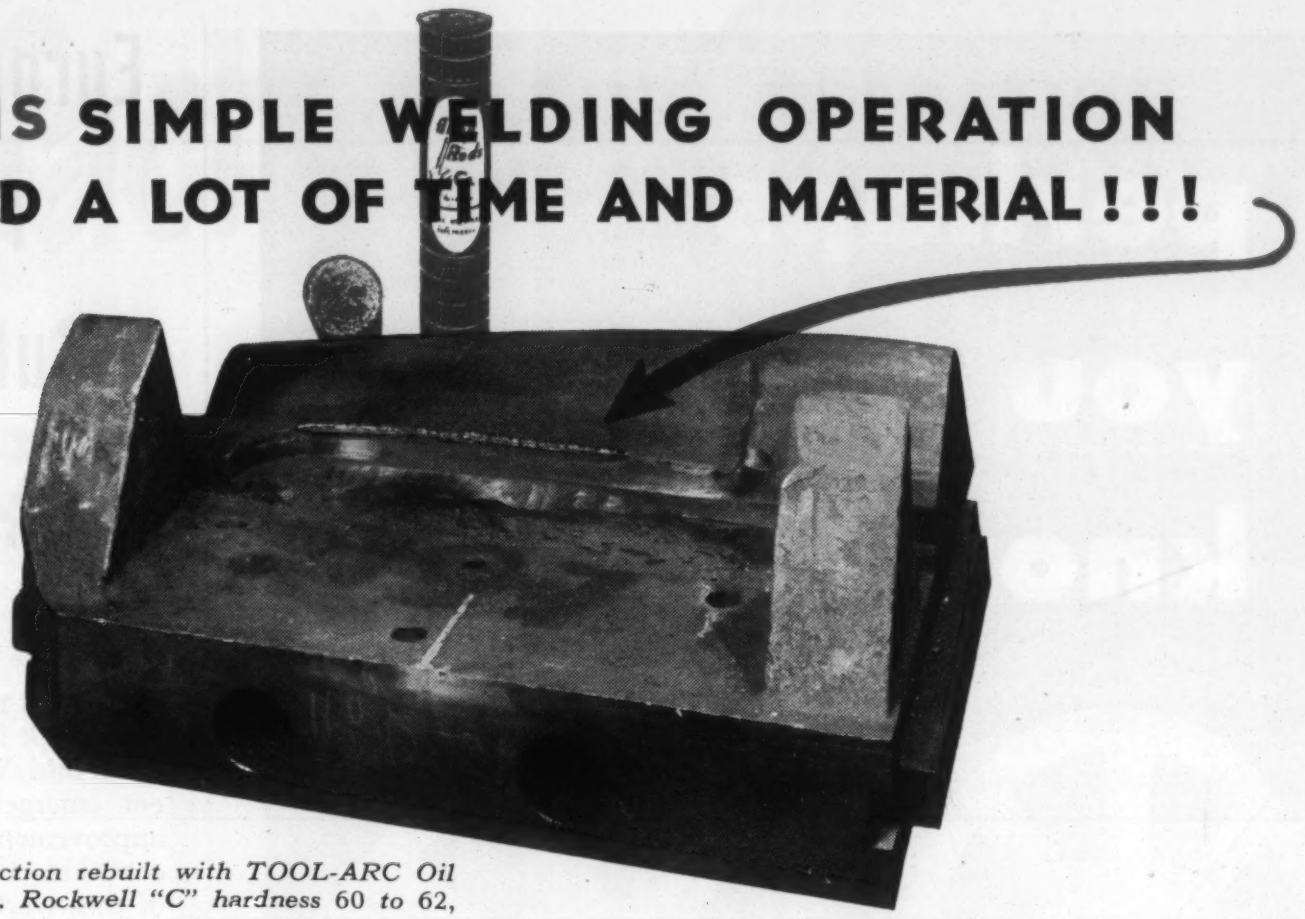


This pocket-size hardness tester provides a simple control method for production line, laboratory and engineering department use.

Operation is simple. A hammer with a nonelastic carboloy tip is allowed to drop a determined distance to rebound to reading position. Conversion charts accompany the tester so that comparative Rockwell or Brinell readings can be quickly obtained.

"Materials Control Orders"
appears on page 7 of this issue

THIS SIMPLE WELDING OPERATION SAVED A LOT OF TIME AND MATERIAL ! ! !



Male flanging die section rebuilt with TOOL-ARC Oil Hardening electrodes. Rockwell "C" hardness 60 to 62, as welded.

TOOL-ARC Conserves Material, Saves Manhours Minimizes Production Delays . . .

Six Basic Types

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Hot Work
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High Speed
TOOL-ARC
Work Hardening

TOOL-ARC electrodes are made by the extruded process to assure uniform coating thickness concentric with the core wire. Result — finer quality weld with greater dependability. These electrodes will deposit tool steel weld metal of any one of six basic types and provide characteristics typical of each type.

FOR:
- Engineering Design Changes
- Rebuilding Worn Tools and Dies
- Composite Fabrication of New Dies

Prolong the life of your tools and dies by refacing with TOOL-ARC. For complete description, properties and welding procedures, ask for Bulletin No. 2519.

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NICKEL-ARC for cast iron
TOOL-ARC for tool steel
WEAR-ARC for hard facing
BRONZE-ARC for general use

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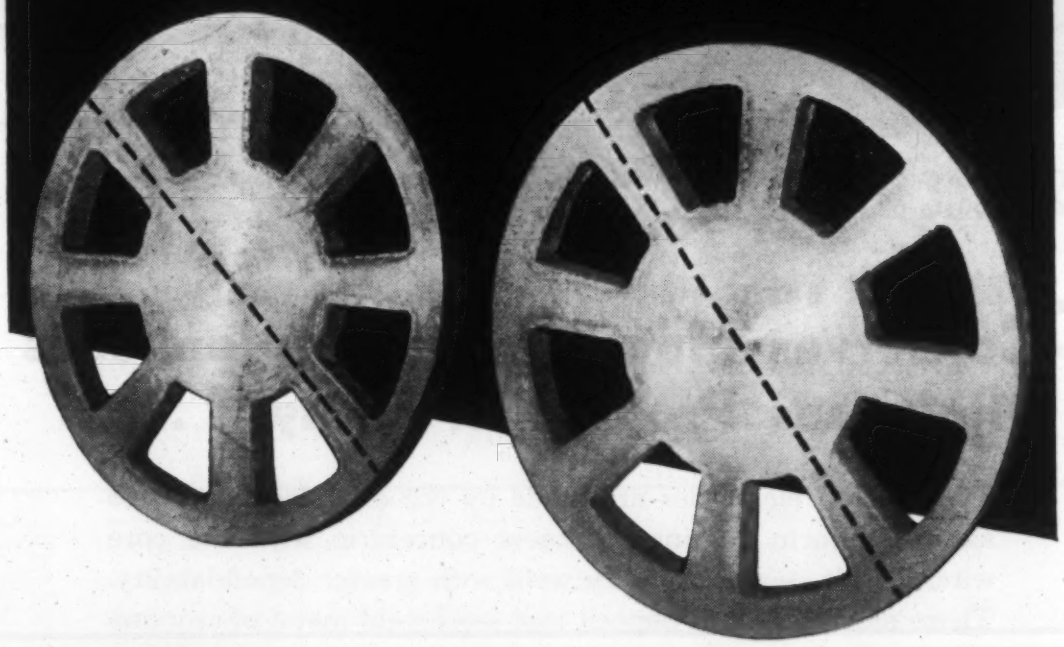

These are two type 304 stainless steel blanks—1¾" thick and 22⁵⁄₁₆" in diameter—rough machined and powder cut to pattern by G. O. Carlson, Inc. The dotted lines indicate where each blank was abrasive cut to produce two identical segments—the form in which dozens of these blanks were shipped to our customer.

Savings in vitally needed material, freight, and fabricating time result from the specially developed varied cutting facilities of G. O. Carlson, Inc.

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Europe Studies Tinplate Substitutes

by W. G. CASS

● WHILE THE TIN shortage has been keenly felt in the United States, both in World War II and in the present emergency, and the search for improvements in the use of phosphate-coated black plate and the substitution of thin electrolytic plates for hot-dip tin coatings has been stimulated, the situation has been even more critical in Europe, and some interesting research has been done in Germany and England.

Germany

Tin plate has some disadvantages in **food cans.** Sulfur blackening and discoloration occurs with albuminous foods, and a metallic taste is sometimes imparted to the can contents. In 1937 several German firms pooled resources to investigate the production and use of phosphate-coated blackplate to avoid these difficulties. This seemed to be the logical answer in view of the tremendous developments in phosphating on sheet metal in the early 30's.

It was found that the corrosion resistance of iron, steel or zinc surfaces increases, according to the density and crystal size of the phosphate coating, even without further treatment. In most cases, however, an additional finish increased protection and gave a more pleasing appearance. One of the special merits of phosphate coatings is the additional adhesion that is provided for subsequent finishes to increase their resistance to under-film corrosion.

Ordinary hot-dip tin plate sometimes requires a coat of enamel; electrolytic plate, being thinner, usually requires this additional protection; phosphated blackplate invariably needs one or two coats of lacquer or enamel. This does not make the cost of blackplate more expensive than tin plate, however, since phos-

(Continued on page 134)

It's a fact that

✓ Some of the very low expansion AlSiMag Ceramics have excellent heat shock qualities and can be heated red hot and suddenly cooled without damage.

✓ AlSiMag Ceramics are ideal elastic bodies. They do not show any plastic deformation and retain their original shape after release from strain.

✓ AlSiMag Ceramic plates can be ground to a flatness of 1 or 2 light bands, and retain this flatness even if subjected to severe temperature changes. What could be better as a reference subject?

✓ AlSiMag Ceramics can be made with varying thermal expansions to match those of many other materials. You can match the expansion of AlSiMag Ceramics with many glasses and metals and obtain a fit which will be retained indefinitely.

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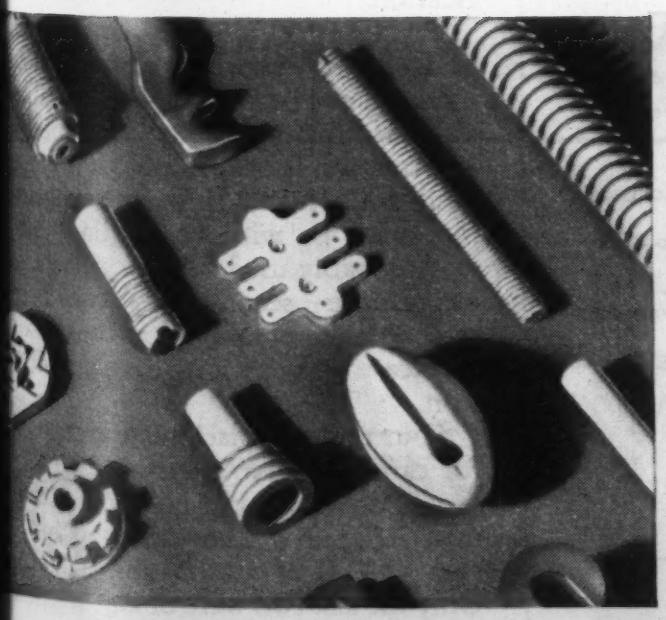

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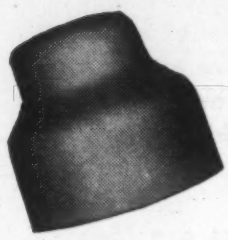

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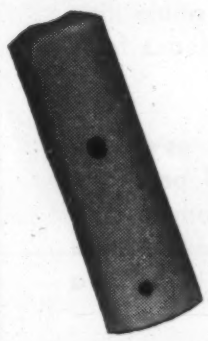

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continued from page 132

phating is a much simpler and cheaper process than tinning. Lacquer is usually desirable on food cans anyway, and the bonding is much more effective to a phosphated surface than to tin plate.

The phosphating processes of the Parker Rust-Proofing Co. and the American Chemical Paint Co. had been adopted in Germany, and several German firms had done some research on the subject in the pre-war years.

The Bonderized coating consists essentially of tertiary zinc phosphate with some amounts of secondary and tertiary iron phosphates. A fine crystalline coating is formed, well anchored to the base. The coating is nonmetallic, contains 0.3-0.5% pores, and though much less porous than some other types of phosphating, is not completely corrosion resistant without a finishing treatment. The thickness and crystal size of the coating can be varied according to the type of bath solution used and conditions of operating. A thin and finely crystalline coating is the best for one-coat lacquering. Of the several kinds of Bonderizing known in Germany, two were tested for the present work: (a) B-5, giving a coating of 0.003 mm in 5 min; and (b) B-2, a coating of 0.01 mm in 5 min.

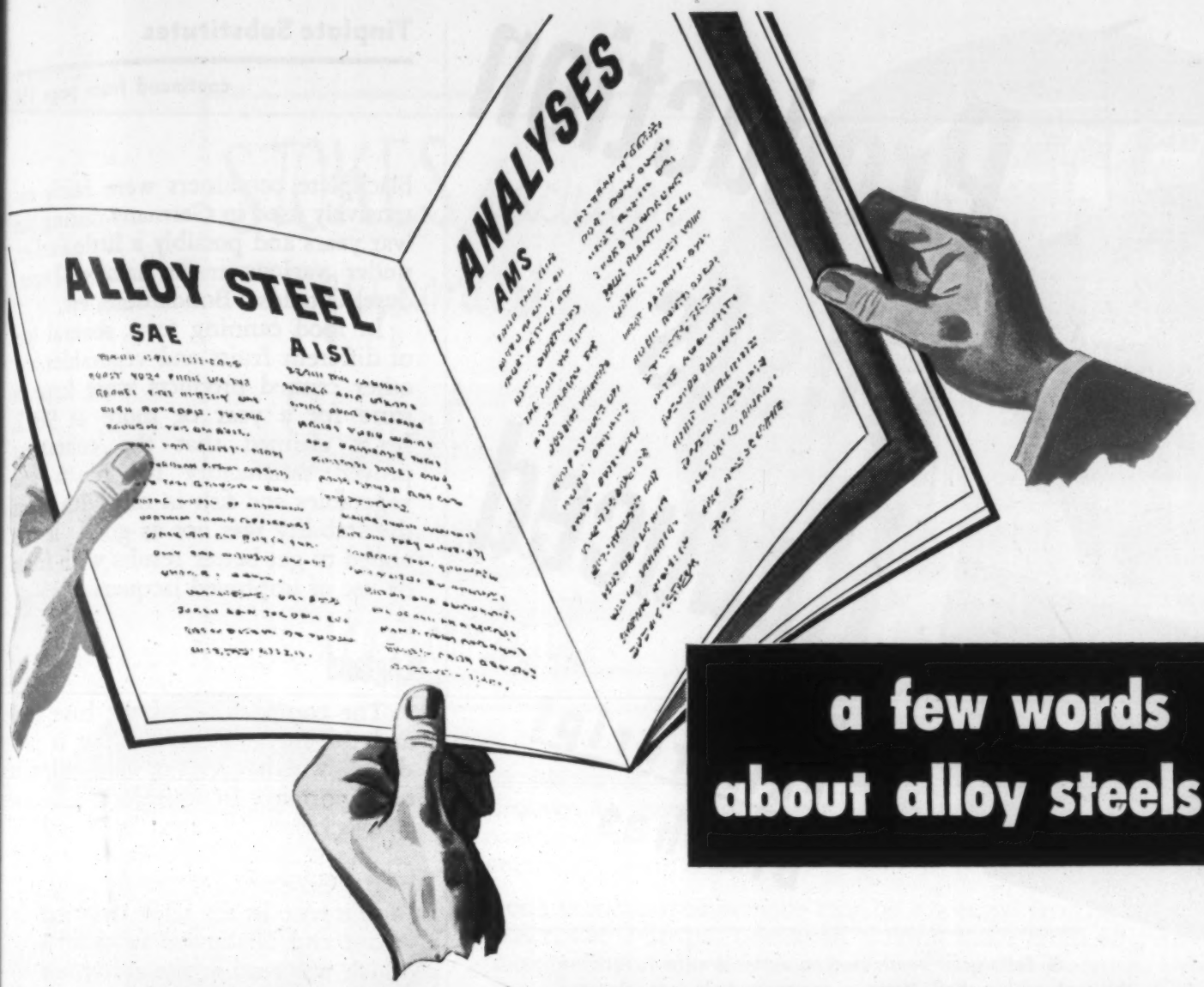
German practice, in the early days and apparently during the war years, was to fabricate the cans of hot- or cold-rolled strip and to weld the seams instead of soldering. This seems to have been more effective and more economical, saving metal by reducing the required overlap. The cans were phosphated and lacquered after fabrication.

Precleaning is important in all phosphating processes, and several methods can be employed—acid, alkaline, sandblasting, etc. No specific information is available as to the type used in Germany, although sandblasting, with or without auxiliary aids, was probably used, since considerable importance seems to have been attached to obtaining a roughened surface to ensure good lacquer adhesion.

Four types of black plate were used for cans: (1) No pretreatment; (2) sandblasted, without phosphate treatment; (3) B-5 phosphating (thin); and (4) B-2 phosphating (thick). Only the last two were of any practical importance.

The Bonderized and lacquered

(Continued on page 136)



a few words about alloy steels...

OR...HOW WE MEET RESTRICTIONS WITH EXPERIENCE

● When you face government restrictions on any of the alloy steels you have been using, it's time to draw on the all-inclusive experience of the Republic 3-Dimension Metallurgical Service.

You and your own metallurgists will get expert assistance from the closely-coordinated Republic three-man team . . . the Field Metallurgist, the Laboratory Metallurgist, and the Mill Metallurgist. Their combined experience in solving problems of alloys, manufacture and steel processing is helping hundreds of alloy steel users make the most of currently available specialized steels.

In spite of the growing restrictions on many alloy steel analyses, you probably can switch your production to one of the many alloy steels being produced by Republic... world's largest producer of alloy and stainless steels.

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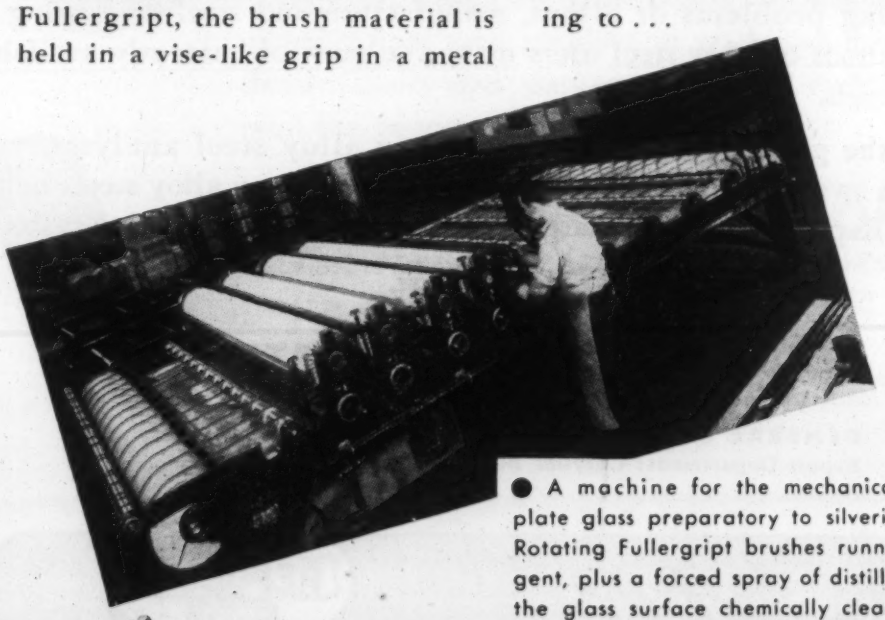

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Tinplate Substitutes

continued from page 134

blackplate containers were fairly extensively used in Germany during the war years and possibly a little earlier, under various trade names—Lemadose, Oftadose, Bonderdose, etc.

In food canning tests, several lots of different fruits and vegetables and other canned products were kept in store for a year or more at 98 F. It is claimed that the containers proved satisfactory for meats and vegetables and fish in oil; with fruits the stability was not as good. It was hoped to get better results with fruits by use of improved lacquers.

England

The composition of the base steel and the method by which it is produced, whether hot- or cold-rolled, is of importance in considering the use of blackplate in cans. Both of these factors seem to have been excluded by the Germans but were brought into prominence in the work described by Adam and Dickinson in their paper which was read at the Autumn 1945 meeting of the Iron and Steel Institute in London.

In that paper they state that the difficulties associated with soldering the side seams of blackplate containers make it impracticable to use blackplate for the entire can. Their work was, therefore, limited mainly to the use of blackplate ends with tinplate (cold reduced sheet) for bodies.

The general conclusion, based on rate of loss of vacuum, hydrogen swell, composition of head space gases, and iron and tin content of canned products is that, when properly protected with two lacquer coats, blackplate ends from cold-reduced steel can be used for most vegetable and meat products, but only in exceptional cases with fruits. The cold-reduced metal was generally better than the hot-rolled.

In tests with phosphated blackplate with one lacquer coating, cans with phosphated ends with a single coating of sulfur resistant lacquer proved to be as good as the tin controls. The particular type of phosphating process used is not stated, although results vary widely according to the method employed.

The natural variability in corrosive properties of the common vegetables was tested, using cans wholly of tinplate and with unphosphated blackplate ends with a double roller coating

(Continued on page 138)

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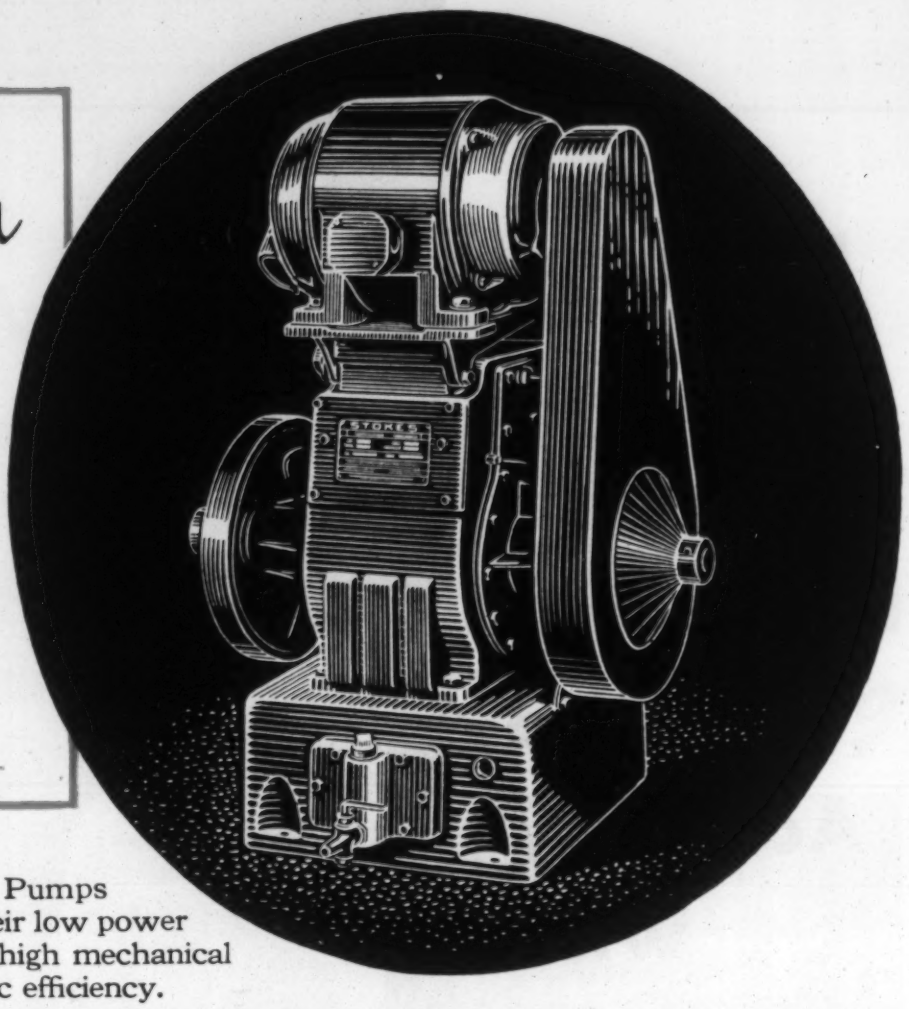

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Tinplate Substitutes

continued from page 136

of sulfur resistant lacquer and one of meat lacquer (three coatings in all). Those with the blackplate ends so coated proved satisfactory, except for beet-root, potatoes, and beans in tomato sauce.

With most fruits the bottom ends of double roller-coated blackplate and phosphated plate were badly attacked and corroded after a week's storage at 95 F. In fact, the phosphated ends were most unsatisfactory for all fruits in lacquered cans. In the case of cans with plain (unlacquered) tin bodies, corrosive action is less marked, owing to the inhibitory action of dissolved tin and the anodic protection given to the steel by the large area of tin exposed.

Hedges and Jordan state that, as a general rule, lacquered steel products are greatly improved if the surface of the steel is phosphated before lacquering, but are still inferior to steel which has been very thinly electro-tinned before lacquering or painting.

Engineering Materials Manual

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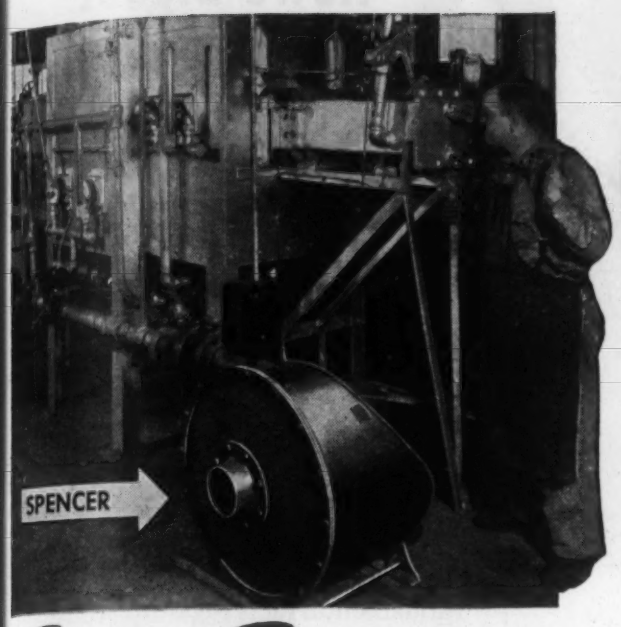

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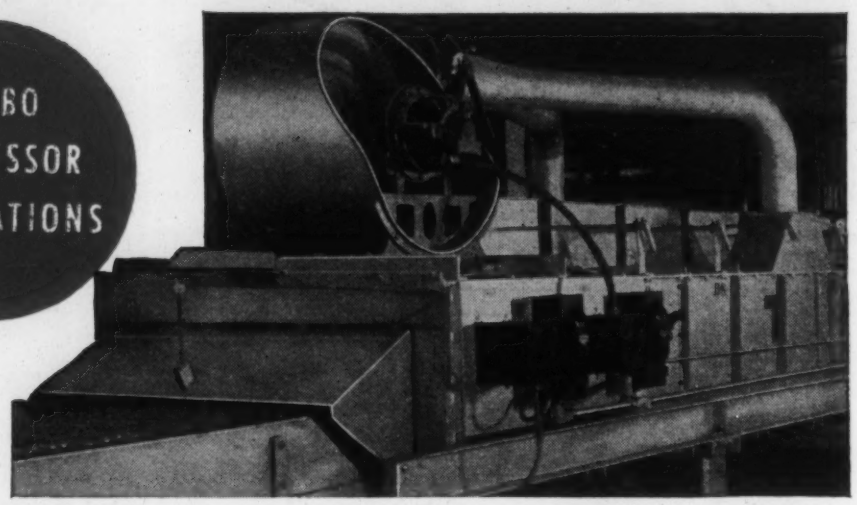

- Ask for the Spencer Turbo Data Book and any of the bulletins mentioned.

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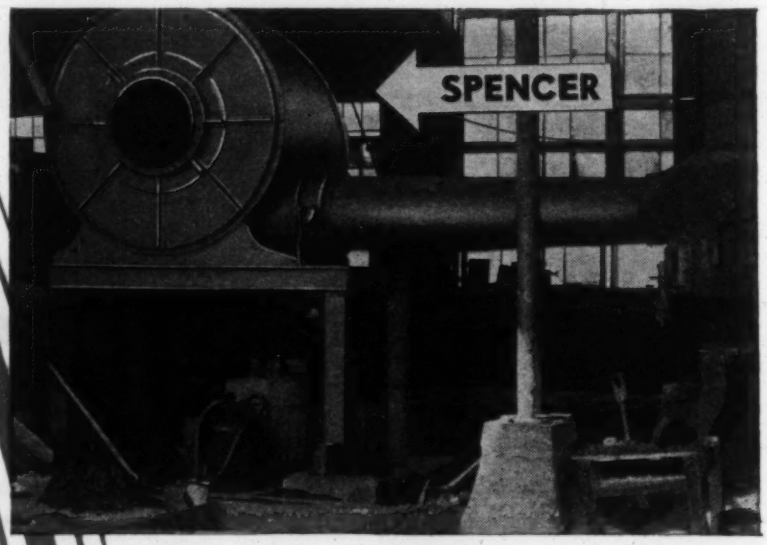

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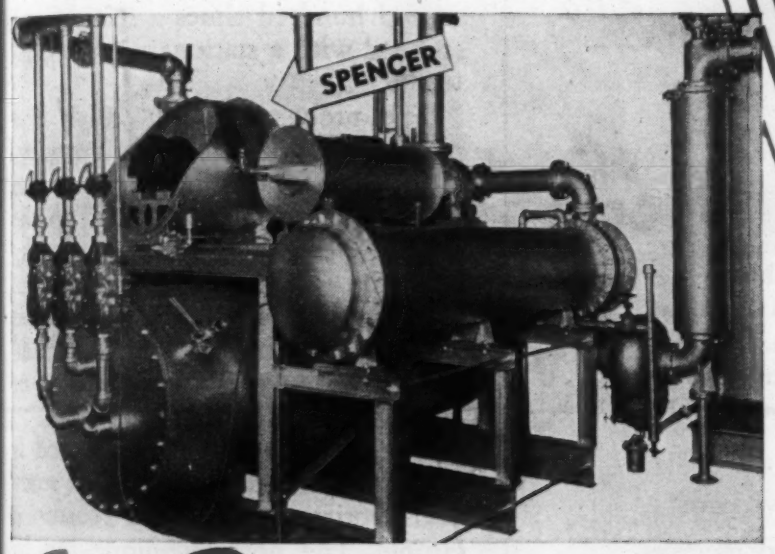

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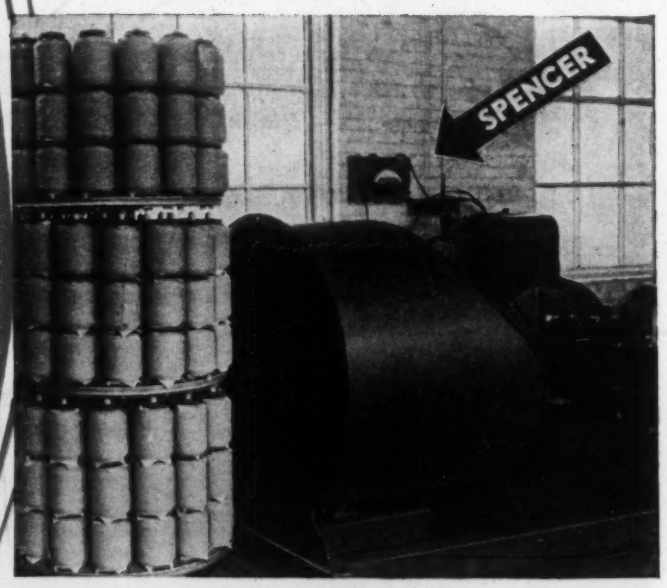

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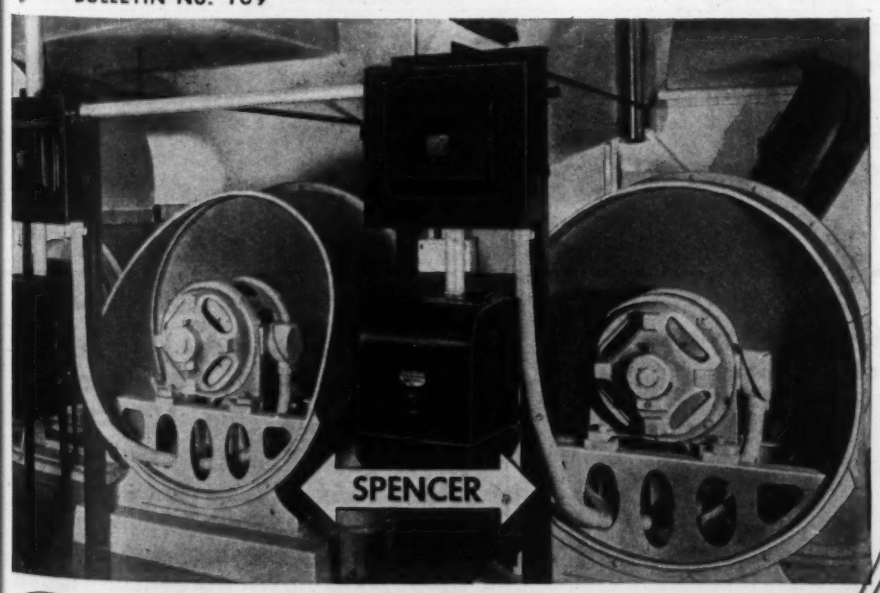

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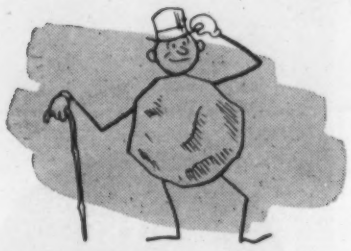

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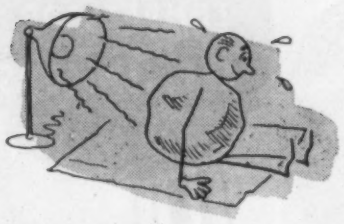

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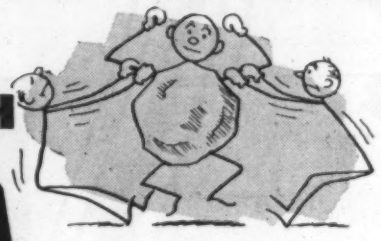

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News Digest

New Technique Developed

(continued from page 13)

Corrosion, of which rust is an example, is caused by thousands of local cells similar to microscopic flashlight batteries. The electrochemical cells are formed by corrosive chemicals and the metal itself.

By studying the action of these tiny, unwanted electrical cells, electrochemists can learn more of the fundamental facts regarding corrosion. The laboratory sample on which corrosion occurs is a metal cylinder. This cylinder is dipped in some corrosive solution, such as sea water, rotated several hundred times a minute, and scanned with a stationary probe electrode.

The probe electrode, which is a plastic arm containing 11 silver wires, is placed about 0.02 in. away from the submerged cylinder. It picks up the minute electrical currents caused by corrosion and enables scientists to measure and study the process. These tiny currents can be amplified and viewed on an oscilloscope screen or photographed for later analysis.

One advantage of this method is that it permits easier and faster study of the entire surface area of a corrosion sample. The new technique can be used for investigations of cathodic protection, corrosion inhibitors, stress corrosion and in fundamental corrosion studies.

Titanium Subsidiary Formed by Mallory and Sharon Steel

P. R. Mallory & Co. of Indianapolis and the Sharon Steel Co. have joined in organizing the Mallory-Sharon Titanium Corp., owned on a 50-50 basis.

The new organization will supply titanium for the armed services for the present. With the growing market for the metal, the combined facilities of the two parent companies will make it possible to melt, fabricate and market titanium and its alloys as new applications can be filled.

Both Mallory and Sharon have been in the titanium field for some time,

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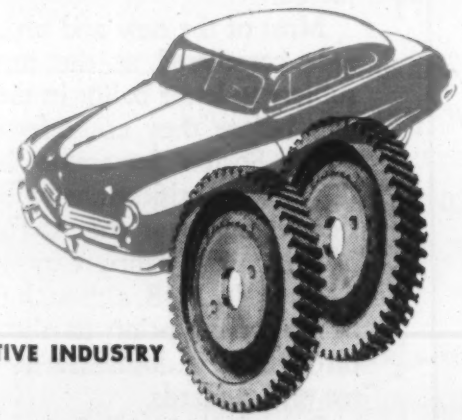

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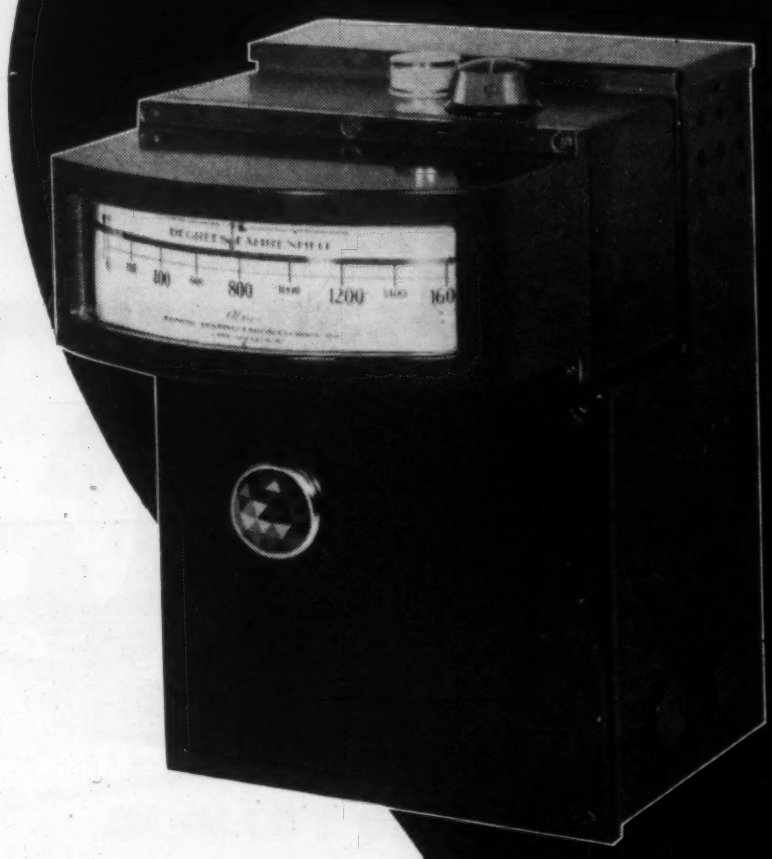

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News Digest

handling complementary functions. Extensive metallurgical research and development work has been done by P. R. Mallory for the Navy Bureau of Aeronautics and on its own initiative over the last 10 years. The Niles Rolling Mill Co., a subsidiary of Sharon Steel, was a pioneer in rolling large titanium sheets.

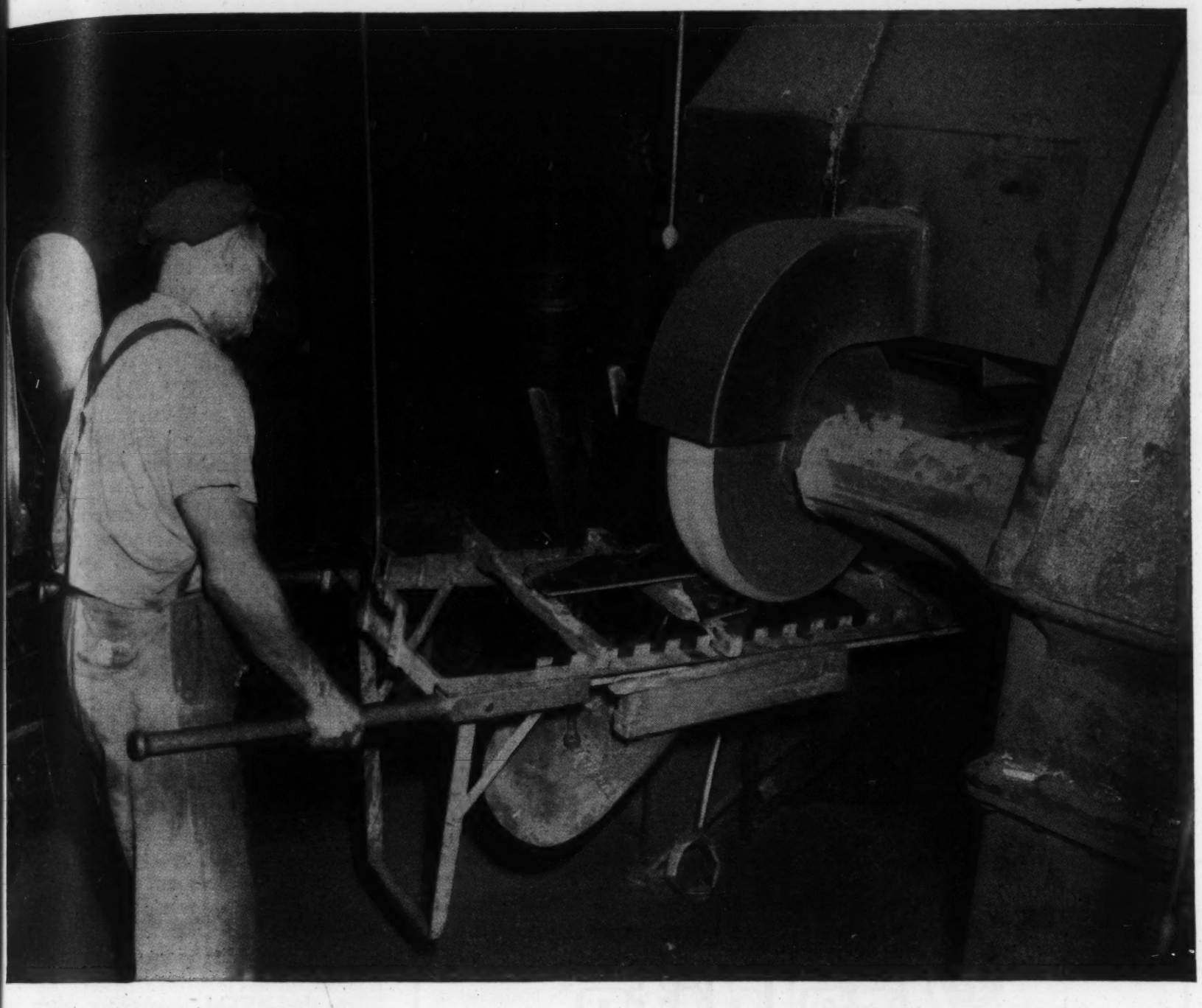
This merger is the third union in the titanium field. The Titanium Metals Corp. of America, set up by the Allegheny Ludlum Steel Corp. and National Lead Co., was the first joint venture in the new metal. In mid 1950, the Remington Arms Co., Inc. and Crucible Steel Co. of America followed suit with Rem-Cru Titanium, Inc., dedicated to the same proposition.

ASTM Committees Complete New Standards

During ASTM Committee Week in Cincinnati, Mar. 5 to 9, much new research work was discussed at the some 200 meetings of the Society's technical committees, and many new specifications and tests for materials and numerous revisions were completed.

Most of the new and revised standards completed at the meeting are subject to letter ballot in the committees before they are referred to the parent Society for action. In general, the new specifications will be considered finally at the ASTM Annual Meeting in Atlantic City during the week of June 18, although some may be approved prior to that meeting through the Administrative Committee on Standards.

One of the highlights of the meetings of Committee E-1 on Methods of Testing and its subgroups was the organization of a new task group on shear and torsion tests. F. S. Mapes, General Electric Co., is chairman of the task group. To aid in preparing a research program, a literature survey is being made and a bibliography dealing with shear and torsion tests will be prepared. A survey will be made on the terms and nomenclature, and the types of specimens and apparatus being employed today in shear and torsion testing. Consideration will be



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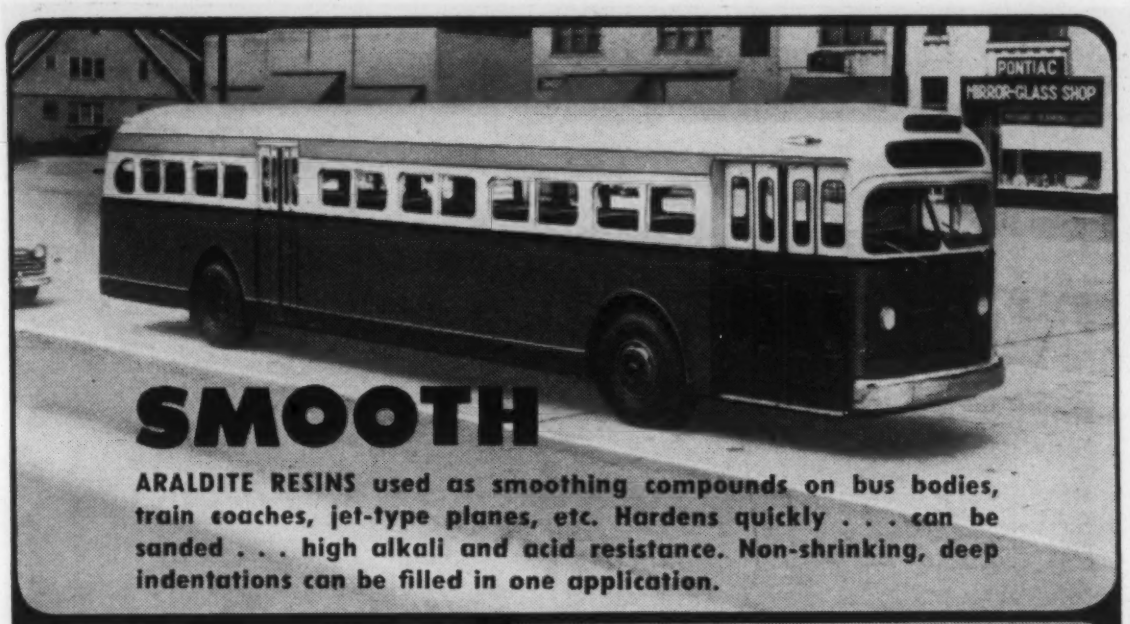

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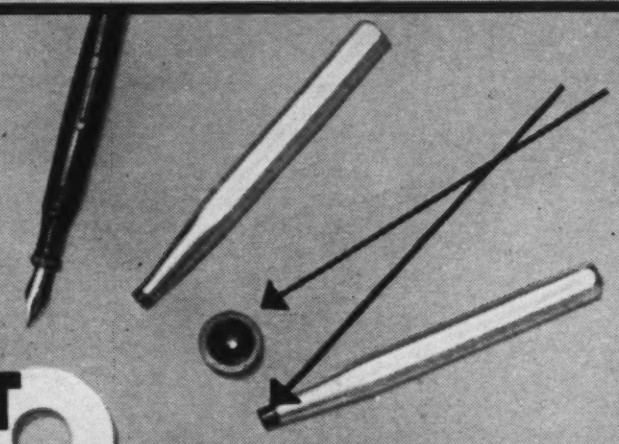

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given to stress-strain relationships in these tests and also to structural property characteristics.

An important decision was made by Committee D-11 on Rubber and Rubber-like Materials to develop specifications for rubber compounds for general application. This work should result in purchase specifications similar to the existing SAE-ASTM Specifications for Rubber and Synthetic Rubber Compounds for Automotive and Aeronautical Applications. There are many applications of rubber compounds in industrial fields and also in domestic electrical and mechanical appliances, and a need for specifications for such applications has been indicated.

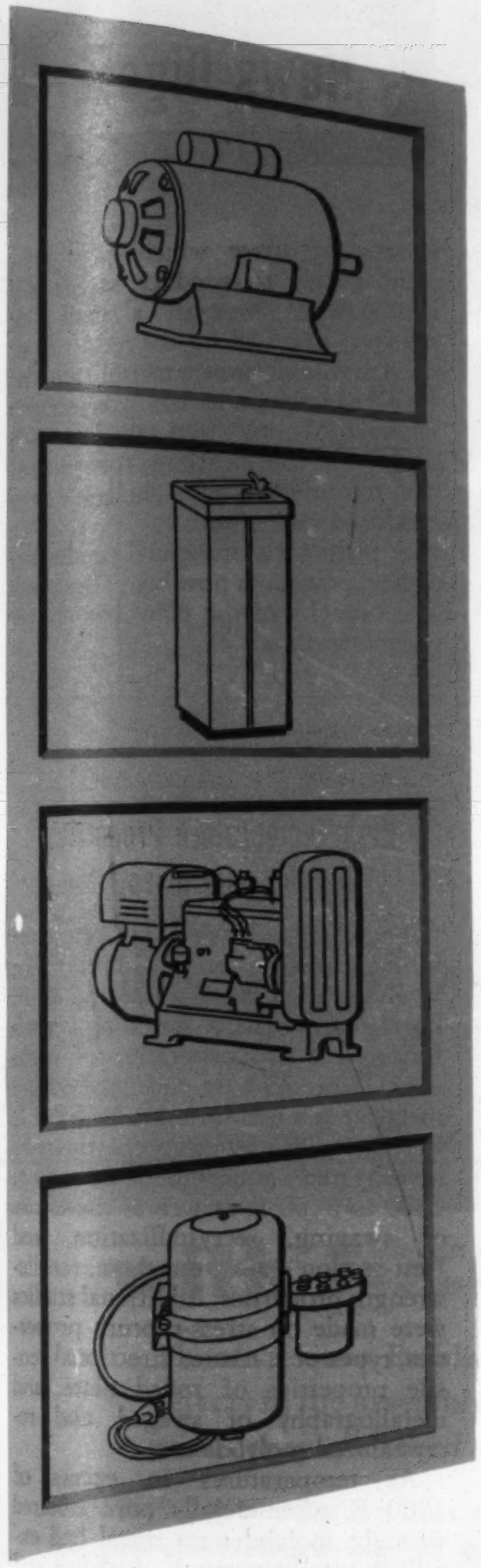
The primary discussion in the meeting of Committee A-10 on Iron-Chromium-Nickel and Related Alloys was the current world situation in regard to availability of columbium and the necessity for substituting columbium-tantalum in all specifications now embodying the present columbium alloy. This suggestion was discussed at great length, and it was agreed that this change would be made in the very near future, possibly in a form similar to the ASTM emergency alternate specifications of the last war.

Committee A-3 on Cast Iron is developing specifications for nodular cast iron, cast iron for elevated temperature, and chilled or white cast iron, as well as a recommended practice for Brinell hardness testing of cast iron. Several grades of nodular cast iron have been described in discussions that are expected to culminate in ASTM specifications.

Iron Powder Produced from Domestic Ore

The Alan Wood Steel Co. is producing small quantities of iron powder from domestic magnetite ore in a pilot plant at its Scrub Oaks Mine, Dover, N. J. This is a significant milestone in the powder metallurgy field, as it is the first time that an iron powder of suitable quality for powder metallurgy use has been produced from a domestic iron ore.

Alan Wood worked intensively for six years on the development of a



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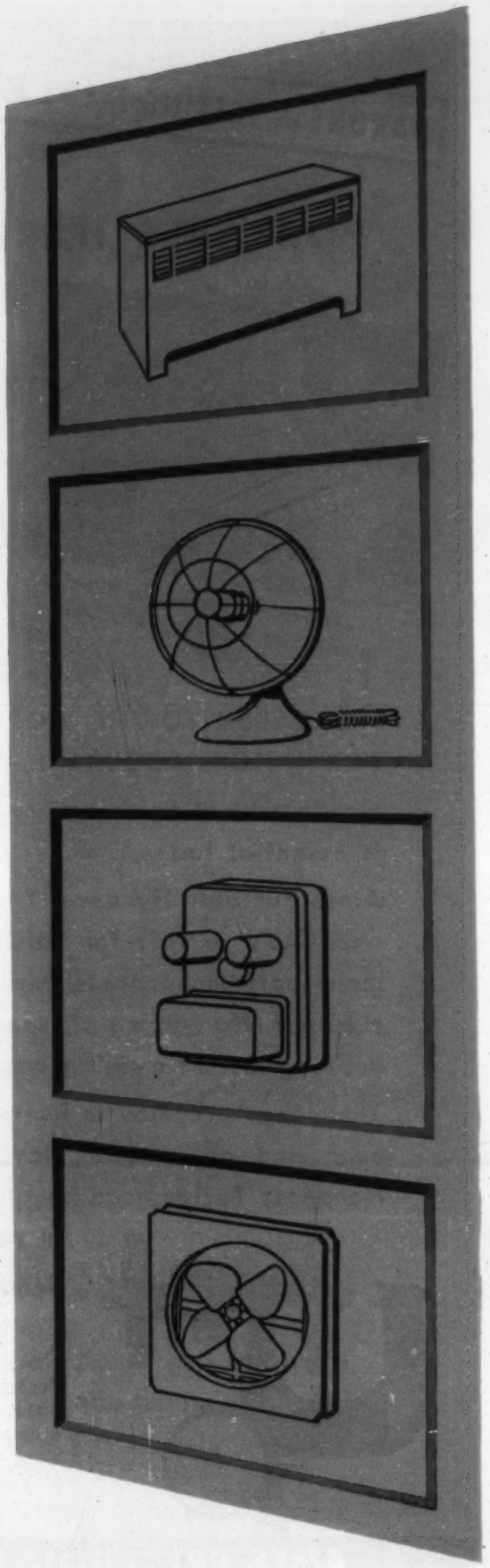

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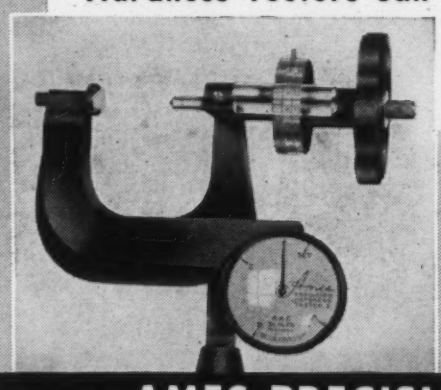

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News Digest

super-concentrate which is of sufficient purity to produce satisfactory iron powder. Recently, a small pilot unit was installed for the reduction of the super concentrate to iron powder. This reduction unit has worked very satisfactorily, and iron powder which passes all specifications for sintered iron rotating bands for shells has been produced and tested.

A plant for commercial production of iron powder is now being designed. The capacity of the plant has not yet been announced.

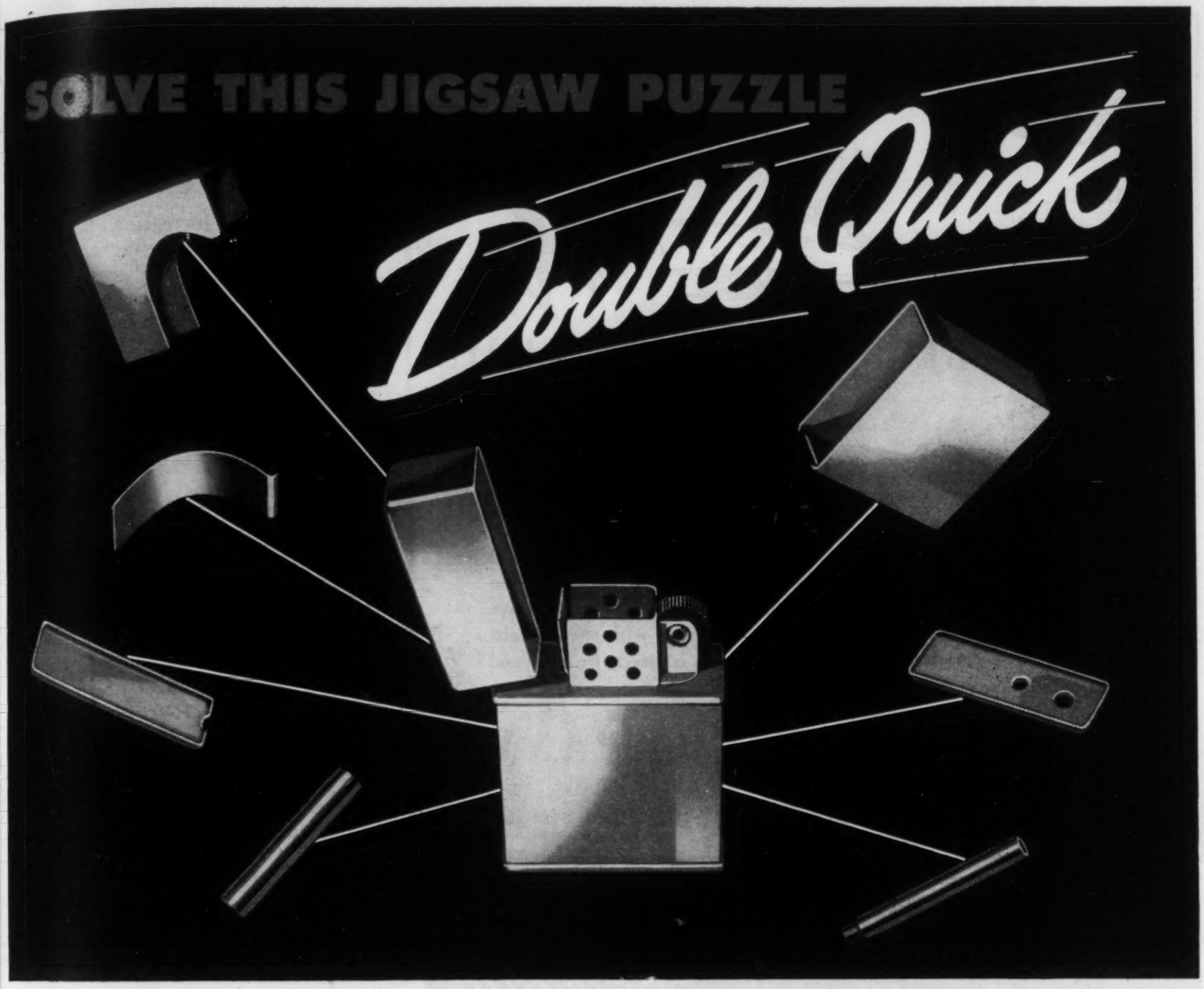
High Temperature Properties of Molybdenum Investigated

The National Advisory Committee for Aeronautics Technical Note 2319, by R. A. Lang, K. C. Dike and H. R. Bear, summarizes a series of investigations on the properties of high-purity, sintered wrought molybdenum metal at temperatures up to 2400 F.

The tensile-strength properties were investigated at temperatures from 1800 to 2400 F, as well as the effects of swaging, recrystallization, and "test-section" area on these tensile-strength properties. Additional studies were made on stress-rupture properties, types of fracture, directional tensile properties of rolled plate, and metallography of swaged and recrystallized molybdenum.

At temperatures in excess of 1800 F, commercially pure sintered wrought molybdenum metal had excellent tensile strength, ductility and stress-rupture life comparable with or superior to other proposed high-temperature materials. At a temperature of 1800 F, the short-time tensile strength varied between 25,310 and 33,670 psi. At 2400 F, the tensile strength varied between 13,070 and 26,100 psi, depending upon manufacturing swaging variables and whether the evaluation temperature was above or below the recrystallization temperature of the specimen evaluated.

Recrystallization lowered the tensile strengths of molybdenum at all temperatures. Recrystallized metal had ductility at elevated temperatures, but was brittle at room temperature. The amount of swaging on the particular bar sizes investigated had little



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REJECTS ELIMINATED—Formerly rejects due to leaking seams and uneven heating were frequent. TOCCO has eliminated these completely.

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News Digest

effect upon increasing the tensile strength, but increasing amounts of swaging progressively lowered the recrystallization temperature. Increasing the test-section cross-sectional area of a specimen had a negligible effect upon the evaluation of the tensile strength.

Wrought molybdenum had a 100-hr stress-rupture life at approximately 19,300 ±300 psi at 1800 F. Recrystallized metal had a 100-hr life at approximately 10,000 psi.

As-swaged molybdenum exhibited a transgranular failure under tension at all temperatures until effective recrystallization occurred. Recrystallized molybdenum exhibited intergranular failure at room temperature; from 1500 to 2000 F, the fracture was predominately transgranular; from 2000 to 2400 F, the fracture reverted to the intergranular type.

Rolled molybdenum plate possessed definite directional properties, having the greater tensile strength in the transverse direction to rolling and the greater ductility in the longitudinal direction of rolling.

Different manufacturers' products, having a similar swaging reduction, had considerably different strength and recrystallization properties.

Study Industrial Demand for Fission Products

New, constructive, industrial uses for by-products of the atomic energy program, through the medium of large-scale employment of fission products, are being investigated on a nationwide basis by Stanford Research Institute for the U. S. Atomic Energy Commission. The immediate objectives of the study are to acquaint industrial concerns with the characteristics of fission products and to obtain the cooperation of industry in developing estimates of their possible utilization.

The scope and objectives of the Stanford Research Institute's fact-finding program are described in a booklet entitled, "Industrial Utilization of Fission Products—A Prospectus for Management." A limited supply of copies is available for interested concerns. They may be ob-

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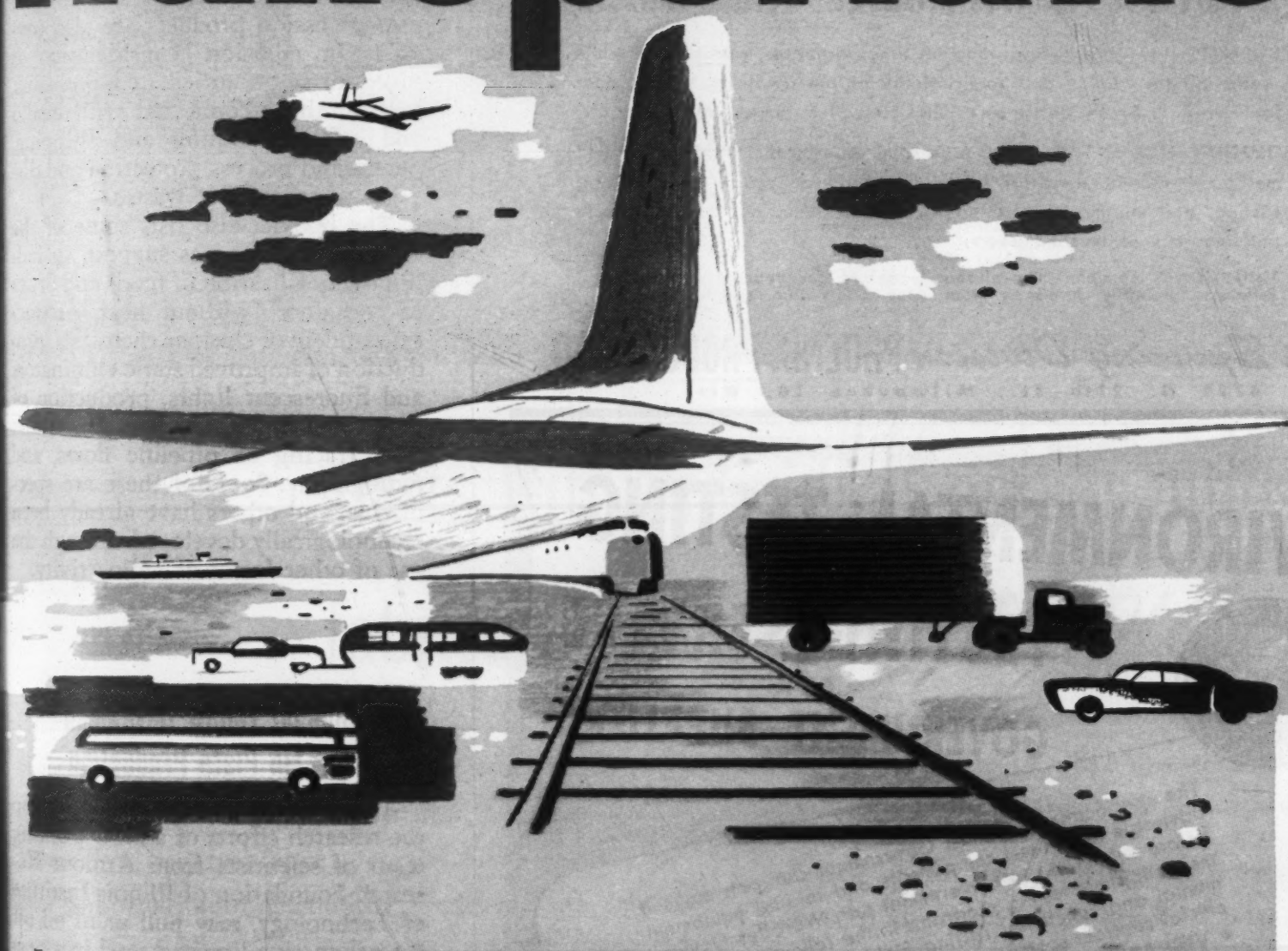
are proving their worth
in the vast field
of

transportation



In anything that moves, by wheel, wing or water, applications of Van Huffel metal tubing and shapes have become standard practice. Whether it is a frame for a modern trailer coach or an intricate part for a jet job, product engineers in the transportation field recognize the advantages in specifying Van Huffel whenever strength, style and simplicity . . . *plus economy* . . . are necessary characteristics of their products. Van Huffel means versatility.

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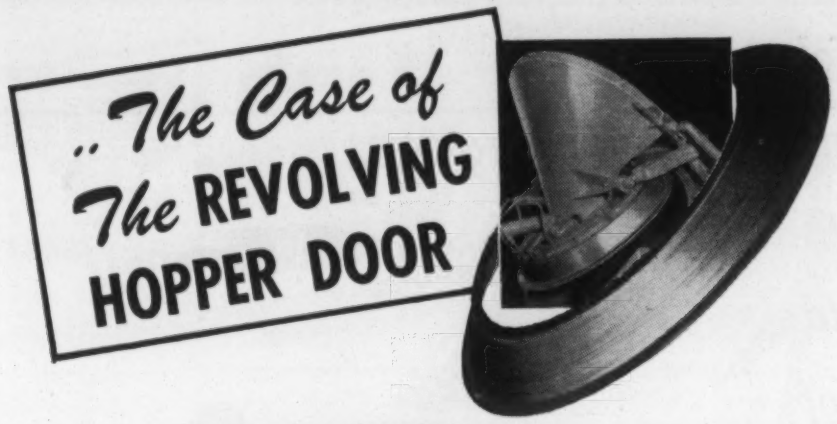

How *Phoenixspun*
Helped Save MAN-HOURS, MATERIALS, And WEIGHT In Producing This Part For "SMITHMOBILE" Truck Mixers

THE PROBLEM:—How to reduce production time, materials, and weight while improving the quality and serviceability of the revolving hopper door for The T. L. Smith Company's "SMITHMOBILE" Truck Mixer.

THE SOLUTION:—Use of #10 U. S. Gauge steel spun by the "PHOENIXSPUN" method — without need for costly dies, reducing weight by replacing casting, and eliminating man-hours for machining due to smoothness and accuracy of finished doors.

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tained by writing to: Project 361, Dept. of Business and Industrial Economics, Stanford Research Institute, Stanford, Calif.

The prospectus points out five of the principal capabilities of fission product materials that might be of interest to industry: the ability to kill organisms, induce chemical reactions, ionize gases, activate phosphors, and produce rays which can penetrate solids. The availability, cost and possible uses of fission products are also covered. In addition, consideration is given to some anticipated problems, such as those connected with health and safety, handling and shipping, patent and process protection and disposal of radioactive wastes.

The booklet also lists some of the uses these properties suggest, including the sterilization of foods and drugs in containers without heat, production of new or cheaper chemicals, production of improved static eliminators and fluorescent lights, production of new types of luminescent paints and tiles, tracing of pipeline flows, and radiography. Some of these are speculative, and others have already been technologically developed through the use of other forms of radioactivity.

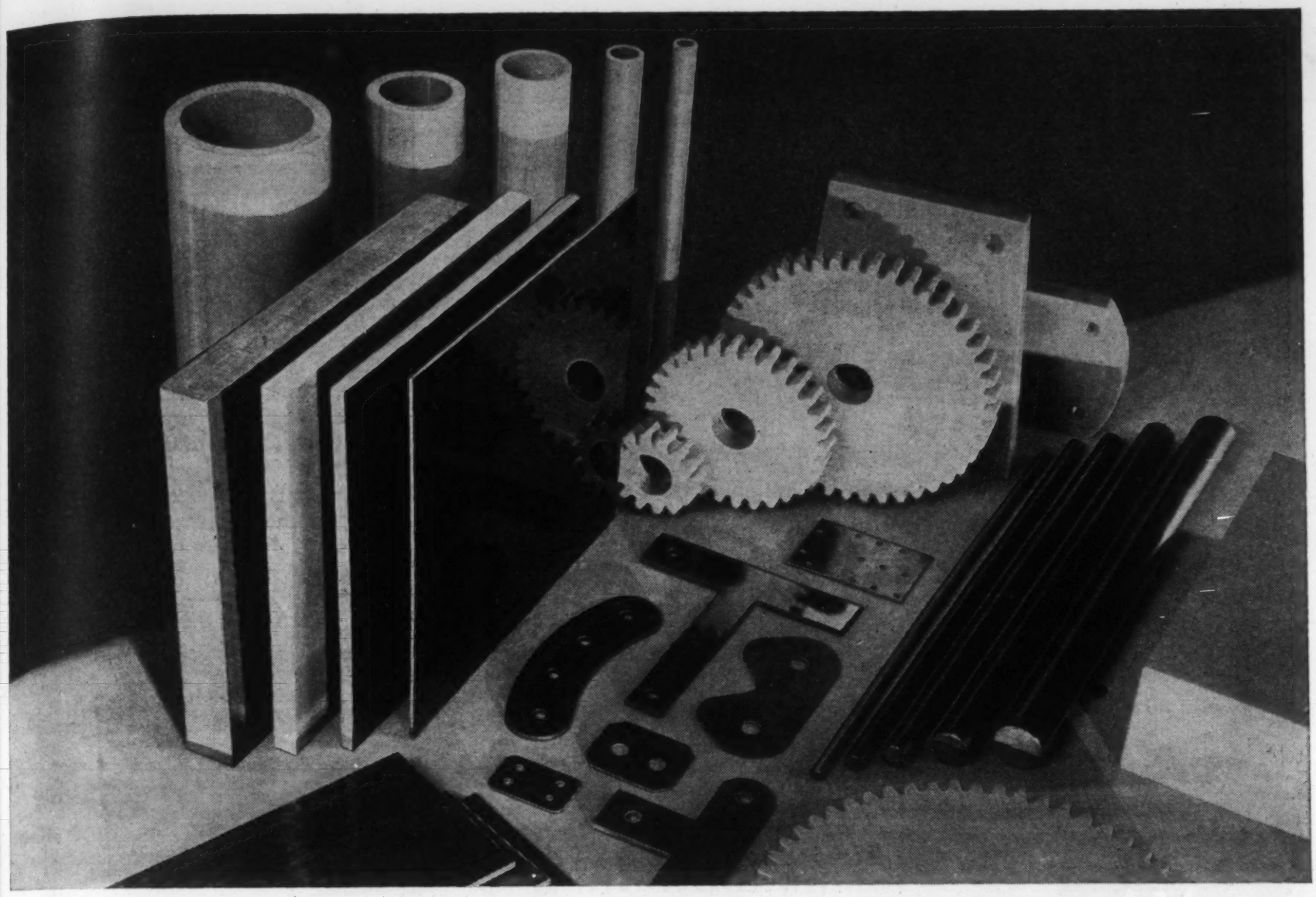
Special Tallow Developed for Tin Plate Production

Tin plate producers, following up the research efforts of a hard-working team of scientists from Armour Research Foundation of Illinois Institute of Technology, may pull palm oil off the production line and send in a new substitute—specially processed tallow.

The switch, now that successful mill tests have been concluded, should bring smiles of relief to meat packers and Uncle Sam's armed forces as well as members of the steel industry, who visualize a possible saving of between $500,000 and $1,000,000 a year at current market prices.

It will aid in maintaining a supply of tin can containers for the armed forces. Meat packers will have a new use for their overabundance of tallow. The steel industry will have a cheaper, readily-accessible substitute oil for their hot dip tinning operations.

Palm oil, imported from the East



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LAMICOID is a thermosetting plastic laminate, made from fillers—such as glass, nylon, paper or fabric—and resins possessing a wide range of properties. This versatile material can be supplied in sheets, rods and tubes—or fabricated into parts to your specifications.

LAMICOID has already proved ideal for gears, pulleys, panels, dials, nameplates, brackets, terminals, spacers, supports, and a host of other items. We'll be glad to share our over 58 years' experience by helping you give *your* products a new, individually-patterned LAMICOID personality. Write today for complete details.

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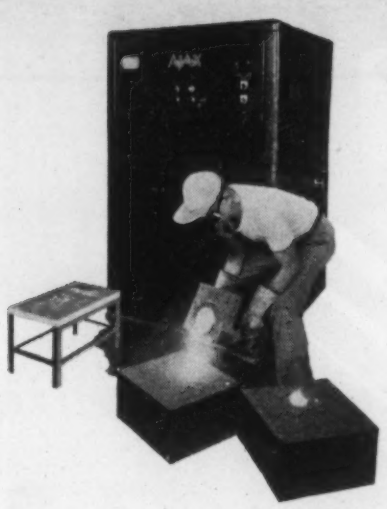

Ajax-Northrup converter-operated furnaces give you high speed precision melting of any alloy, ferrous or non-ferrous, in quantities from 3 to 60 lbs. Melts 30 lbs. of brass in 20 minutes, 17 lbs. of steel in 35 minutes, always with extremely close control over composition and pouring temperatures. Self-tuning push-button control—no adjustment needed while melting. Quick, easy change-over from one alloy to another—ideal for laboratory work, precision casting, any melting application where precision is a *must* in every melt. Also available in 3, 6, and 40 kw. sizes; and in generator operated units to 8 tons.

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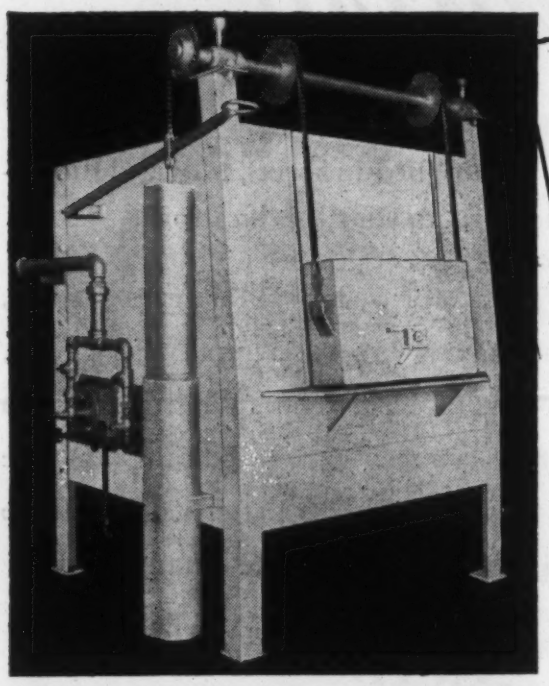

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Write for Bulletin 413.

Rockwell builds many types of batch or conveyor furnaces and ovens; strip and wire winding and cleaning machines; handling equipment; non-ferrous rod mills; special fabrications.

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Indies and North Africa, has constantly troubled the steel industry. Costs are high and unstable. And in time of war, enemy action against shipping could choke off long supply lines. Some 7,000 tons of palm oil are used annually for hot dip tinning in the U. S. Numerous substitutes for hot dip tinning have been tried. Several patents have been issued. But up till now the industry has largely continued to use palm oil.

News of Engineers

John D. Jones has joined Brainard Steel Co., a subsidiary of Sharon Steel Corp., as chief operations engineer. He was formerly associated with the Blaw Knox Corp. as production manager of roll producing facilities.

Davey Compressor Co. has promoted *Everett A. Utecht* to the position of assistant chief engineer.

Dr. *M. F. Browne* has joined the Research Dept. of the Plaskon Div., Libbey-Owens-Ford Co., where he will participate in research on glues and industrial resins.

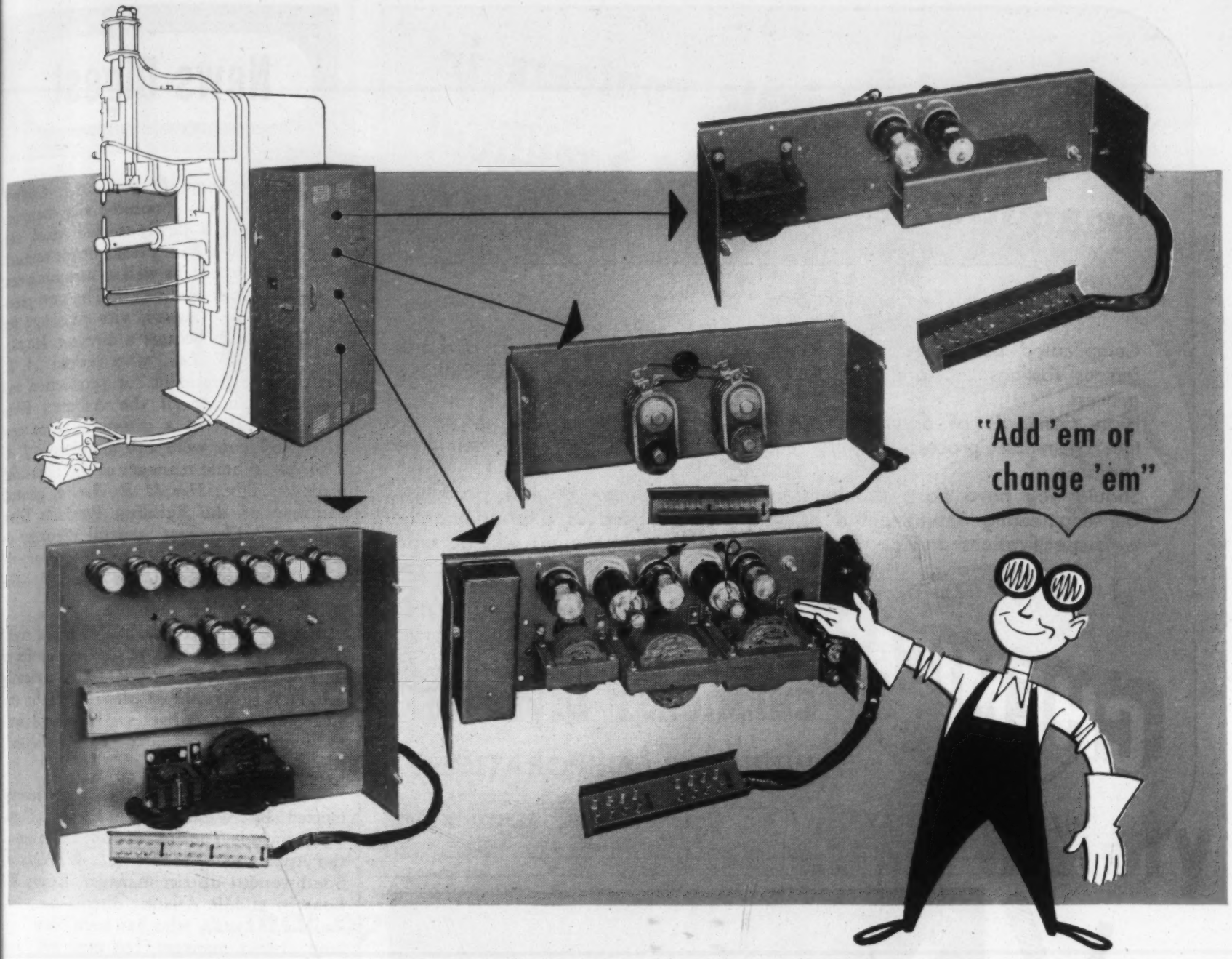
Eriez Manufacturing Co. has announced several changes within its organization. *A. F. Merwin* was elected chairman of the board of directors. *R. F. Merwin* succeeds him as president and general manager. *Earl C. Miller* was made executive assistant to the president. *M. L. Cramer* is now sales engineer. *Emerson J. Tenpas* became development engineer. And *W. L. Lukowski* was named design engineer.

Dr. *Ivor E. Campbell* has been appointed supervisor of research on chemical problems in nonferrous metallurgy at Battelle Memorial Institute. Dr. Campbell has been a member of the Battelle staff since 1943. It was also announced that Dr. *Robert I. Jaffee*, another long-time member of the Battelle staff, was named supervisor of research in nonferrous physical metallurgy.

Two development engineers have been promoted by Goodyear Tire & Rubber Co. *W. H. DeBruin* was named resident contact engineer. And *T. J. Thaden* succeeds Mr. DeBruin in farm tire development.

Gordon Kiddoo, formerly director of research and development for Continental Carbon Co., was appointed assistant director of the Petrochemical Research Dept. of National Research Corp.

A regrouping of executive responsibilities in Johns-Manville Corp. has caused the



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Interchange components to keep it abreast of production changes

Why buy a resistance welding control today and "put it out to pasture" tomorrow because of obsolescence due to production changes?

Westinghouse Welding Controls keep pace with such changes. When a new welding technique is required, synchronous or nonsynchronous, seam or spot—interchange components to meet the need.

A Westinghouse Welding Control consists of a packaged combination of units to handle the initial technique. Each unit is self-contained and pre-wired at the factory. A polarized plug ties each unit into the basic circuit. Thus, it is a simple matter to replace these components or add new ones.

A complete line of component units meets most every welding technique you will use. Spot welding, seam welding, synchronous, nonsynchronous, slope control, heat control, weld treatment . . . there's a component to handle a wide range of each function.

Your Westinghouse representative will show you in detail how you can increase the life-span of your resistance welding control. Ask him for a copy of Booklet B-4309 or write direct to Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-27007

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High standards of accuracy and finish are always assured. Moreover, the chemicast process is very economical and orders are completed rapidly.

Should you have parts problems in the development of new products—our engineering department is at your service. Send us a print, together with specifications and pertinent data . . recommendations will be made with no obligation whatsoever on your part.

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If your assembly requires a threaded pin for use in either metal or plastic, call on Hassall. We can offer you substantial savings in costs and prompt delivery even on small orders.

Size range: diameters 1/32" to 1/8"—lengths to 1". These threaded pins can be produced with threads, knurls and with either straight or spiral flutes.

If your problem involves a hinge pin, an insert or a small threaded pin for some other purpose, we can supply it in a wide variety of metals and in suitable plated finishes.

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following changes in personnel: *Clifford F. Rassweiler* was appointed vice chairman of the board, a newly-created office, and will continue as vice president for research and development, as well as assuming new responsibilities as director. The new president is *L. M. Cassidy,* vice president for sales, who also became a director. He succeeded *R. W. Lea,* who retired. *A. R. Fisher,* vice president for production and general manager of the Asbestos Fibre Div., was elected a director. Three new vice presidents were also appointed: *J. A. O'Brien,* general manager of the Industrial Products Div.; *Harold R. Berlin,* general manager of the Building Products Div.; and *A. S. Elsenbost,* general manager of the Celite Div. All three were formerly vice presidents of Johns-Manville Sales Corp., a J-M subsidiary.

Deane R. Ebey has been named coordinator of defense activities for plastics at The Dow Chemical Co. He previously served as supervisor of plastics sales in the Company's Los Angeles office, and will now make his headquarters at Midland, Mich.

Four new vice presidents were recently elected by Westinghouse Electric Corp. They include *Tomlinson Fort,* manager of the Apparatus Sales Dept.; *L. W. McLeod,* Southwestern district manager; *Emery W. Loomis,* middle Atlantic district manager; and *L. E. Lynde,* who has been New England district manager, but now will head the Company's Washington, D. C., government office. It was also announced that *L. D. Rigdon* was named assistant to the vice president in charge of manufacturing. *C. G. Wallis* succeeds Mr. Rigdon as manager of the Headquarters Manufacturing Div.

A. L. Geisinger has been appointed a vice president of the Diamond Alkali Co. He is also president of the Martin Dennis Co., a division of Diamond Alkali.

Sun Tube Corp. has elected *R. Smith Schenk* president of the company. He succeeds *R. R. Leonard,* who resigned.

Robert W. Lea, who retired as president of the Johns-Manville Corp., has joined Olin Industries, Inc.

Ladish Co. has appointed *E. O. Dipow* vice president in charge of research and metallurgy, and *T. L. Swansen* vice president in charge of manufacturing.

Joseph Mazia resigned as chief of the Rust Proofing Div. of the American Chemical Paint Co. and has entered business for himself as a consulting engineer, with offices located at 1424 K St., N. W., Washington 5, D. C.

Koppers Co., Inc. has appointed *C. A. Krol* a vice president of Koppers Engineering & Construction Div. Mr. Krol is management representative for the Company in Chile, South America.

C. W. Bendigo has joined the New

Vibrin case history

...that opens up new polyester potentials

In the dramatic history of plastics, it is difficult to single out the stars. Yet, certainly, the rise of polyester plastic resins has made one of the most exciting stories.

In the few years from 1946 to 1950, polyester sales have grown from 1½ million pounds to 7½ million pounds — a full five-fold increase!

Polyesters are taking over the manufacture of hundreds of products — tubing, fishing rods, boat hulls, trailer parts, lamp shades, furniture, stand-up screens, light diffusers, aircraft parts, many, many more. Again and again, polyesters have introduced *higher product quality* and *lower production cost.*

Just as an example, see what Naugatuck's new Vibrin polyester has done for the battery boxes produced by Lanfare Molded Products, Inc., Toledo, Ohio, for the Nu-Form Battery Corporation, Port Chester, Ohio. Then send the coupon below for the facts about what Vibrin can do for *your* product.

Vibrin has made battery boxes *light, strong, heat-resistant* and *corrosion-resistant.* And it can produce them more rapidly.

What's behind all this? See the notable list of Vibrin properties given here. Vibrin is a product of the Naugatuck Chemical Division of the United States Rubber Company. Insure your plastics future on the *solid base* of Naugatuck — a reliable source of quality products with which you can build lasting leadership in the years to come.

Some outstanding Vibrin properties: Easy to handle — lightweight finished products • Cures without porosity • 100% reactivity — no weight change • Electrical grades — low water absorption • Wide hardness range • Full color range • Flame-resistant types

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Naugatuck Chemical Plastics Division, Elm St., 15, Naugatuck, Conn.
Without charge, send technical data on properties, uses, handling methods (specify desired end products).

I understand that, from this data, I can order suitable, free experimental samples.

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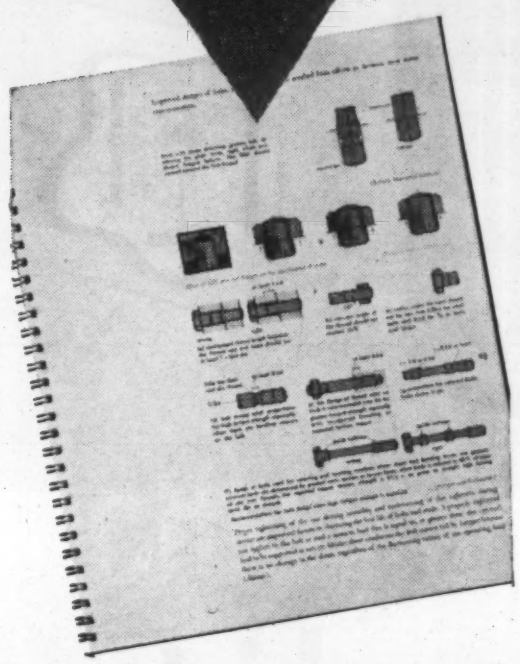

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72 pages of valuable information on scientific design and metallurgical data—write for it now . . .

Success in designing steel components—avoidance of localized stresses — good design and bad design from the metallurgical viewpoint—steel selection and treatment as they affect the design engineer. This invaluable book gives the answers!

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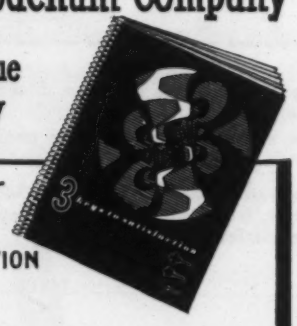

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Products Development Dept. of American Cyanamid Co. For the past five years Mr. Bendigo was editor-in-chief of *Textile World Magazine.*

The Yale & Towne Manufacturing Co. has named *Albert A. Goodman* manager of quality control for its Philadelphia Div. Mr. Goodman previously served as supervisor of quality control for the Steam Div. of Westinghouse Electric Corp.

A. G. Postlethwait recently was elected a vice president of the Lord Manufacturing Co.

Volco Brass & Copper Co. has appointed *Frederick D. Kaeler* as director of government services. He will make his headquarters in Washington, D. C.

Charles E. Wilderman, division manager, and *Daniel E. Waterbury,* production control manager, were both promoted to the position of vice president of Utica Drop Forge & Tool Corp.

Andrel Products Corp. has named *Marvin Friedman* production manager and secretary.

R. W. Walker, vice president of the Mack Motor Truck Corp., was appointed executive vice president and a director of Brunswick Ordnance Corp., a wholly-owned subsidiary of Mack Trucks, Inc.

K. C. Gardner, Jr., vice president in charge of operations for United Engineering & Foundry Co., was elected a member of the board of directors and of the executive committee. Simultaneously, it was announced that *C. W. Correll* was named assistant treasurer of the Company.

A new assistant directorship has been created by the Battelle Memorial Institute, and *Dr. Bruce W. Gonser,* associated with Battelle since 1934, was assigned to the post.

The appointment of additional research specialists to the staff of *Southwest Research Institute* occurred recently. They include: William W. Bradshaw, Kenneth Brady, James Bright, William J. Burkett, Jr., Robert A. Doak, Jr., E. J. Dower, Colonel C. Kinney Longacre (U.S.A.F. Retired), John Mannix, Mrs. Cheryle C. Smith and W. A. Strutman.

General Electric Co. has announced the deaths of two of its members. *Guy A. Moffett,* recently appointed assistant manager of engineering of GE's Control Div., died after a short illness. And *Elliott D. Harrington,* vice chairman and secretary of the Defense Projects and Priorities Committee of GE's Small & Medium Motor Divs., succumbed to a heart attack.

William Watson, Sr., former vice president in charge of manufacturing at Allis-

Luster-on® KHAKI DRAB ZINC DIP BETTER THAN BEST HOPES

Announced a few weeks ago as an olive drab finish for zinc plate by the makers of Luster-on Bright Dips, Chemical Corporation's latest conversion coating is exceeding highest expectations. The first batches in the field indicate even better color and film stability.

Referred to as olive drab or light khaki, Company has settled on official name of "Luster-on KHAKI DRAB." When diluted one part of KHAKI DRAB to seven parts water, the work comes out a light iridescent tan; diluted one to ten, color is rich bronze brown.

Ideal For Defense Work

KHAKI DRAB is an economical, quick, room-temperature dip for work as it comes from zinc plating line. KHAKI DRAB finish will withstand salt spray corrosion tests of 200 hours. This far exceeds government requirements of 100-hour exposure, so KHAKI DRAB should meet any U. S. Government specification. KHAKI DRAB is an entirely new type of formulation, differs from any drab on the market.

Strong Adhesion to Paint

When finished part is to be painted or enamelled, Luster-on KHAKI DRAB gives under-paint corrosion protection, prevents attack at paint breaks or scratches, guards hidden surfaces. KHAKI DRAB is the ideal adhesive base to bond paint to zinc, grips to all types of organic finishes, resists chipping or marring.

Now Released to General Industry

When first announced the new khaki finish was restricted to Government orders. Now Chemical Corporation officials have given nod to full release to include civilian goods (DO's are given preference). Reason given is that new KHAKI DRAB is economical in use of critical materials. Replacing cadmium and nickel with zinc is first economy. This part is not largely required by NPA orders. Second economy is that KHAKI DRAB uses less ingredients in short supply per square foot of work tested than companion Luster-on Bright Dips, Utility-15 and Utility-25.

Utility Still Tops for Bright Work

Where brilliance is desired to replace chromium, nickel or cadmium, Luster-on Utility–15 or–25 is producing amazing results over ordinary zinc plate at costs of a fifth of a cent per square foot. Unequalled by any other product, Luster-on Utility is the choice of American Industry. No war-time substitute, it is the choice of engineers who consider cost, ease of application and control, appearance and protective value.

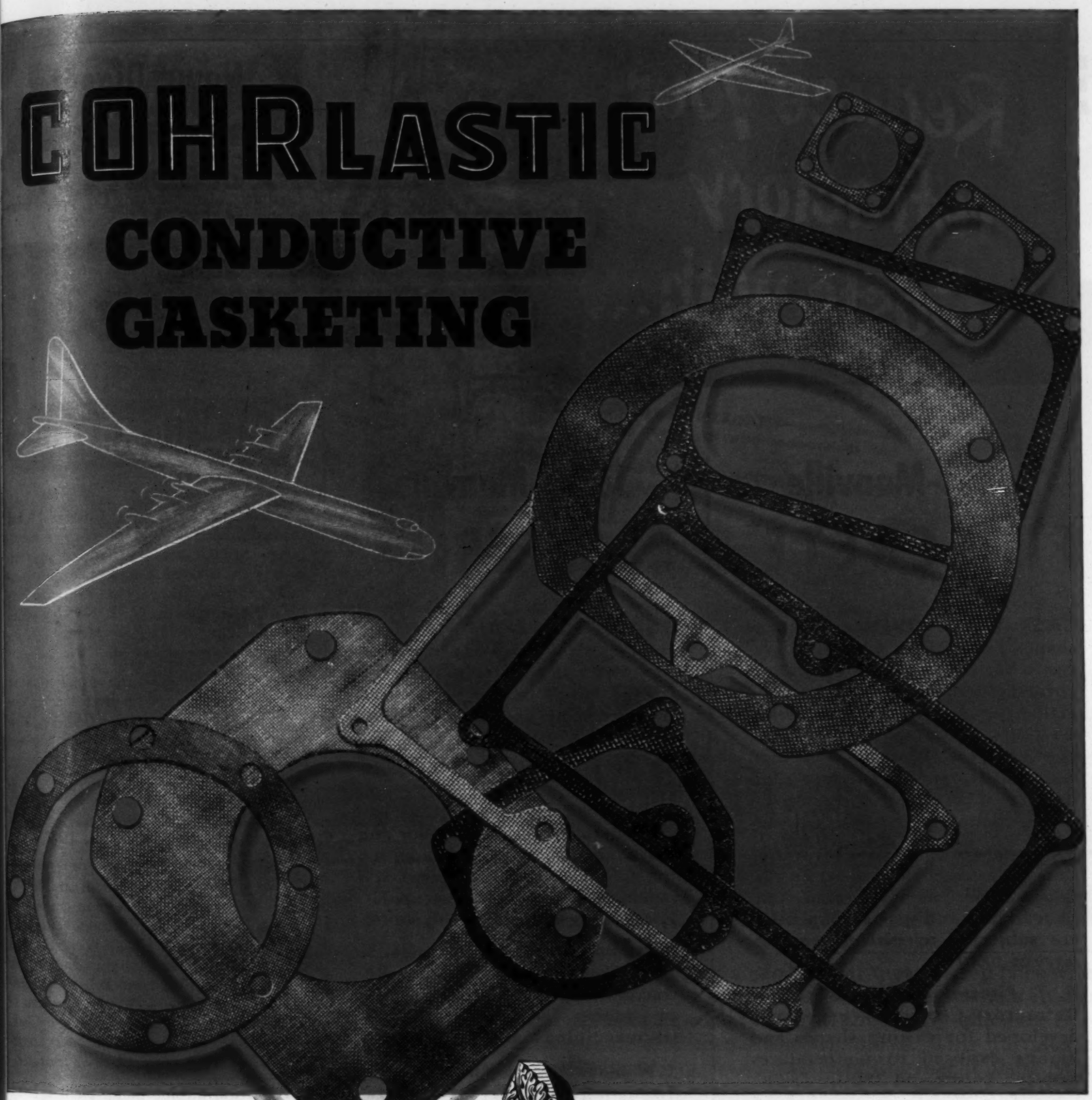
Sample Parts Treated Free

Sample parts sent to laboratory will be processed with either Luster-on KHAKI DRAB or Utility Bright Dip and returned without obligation. Technical advice for conversions to Luster-on is available. Address inquiries to The Chemical Corporation, 60 Waltham Avenue, Springfield 9, Mass.

(Adv.)

COHRLASTIC

CONDUCTIVE GASKETING



A special gasketing that both seals and conducts high frequency currents. It makes an air-tight seal and yet prevents leakage of high frequencies between the bolt holes.

Cohrlastic conductive gasketing provides a continuous mounting and minimizes high frequency losses that affect radio operation.

It is widely used in aircraft (1) between the magnetos and their bases, (2) in the ignition harness, (3) in quick disconnect plugs and (4) wherever shielding is required.

Cohrlastic conductive gasketing is available in three different thicknesses—.016", .020" and .028" in rolls 8" wide and in the finished gaskets on a custom basis. Write for samples, prices and data sheets.

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Johns-Manville FIRECRETE*

CAST YOUR OWN refractory shapes and linings with J-M Firecrete. Burner blocks, door linings, covers, crucibles and countless special shapes are ready for use within 24 hours. Minimum drying shrinkage and firing shrinkage with high resistance to spalling reduce shutdowns—increase production—lower operating costs.

3X Firecrete—3000F Refractory Concrete—for casting burner blocks, door linings, crucible furnaces, complete linings and special shapes that are subjected to *soaking temperatures* of *3000F.*

H. T. Firecrete—High Heat Duty Refractory Concrete—especially developed for casting shapes and linings exposed to temperatures between 2400F and 2800F.

Standard Firecrete—Intermediate Heat Duty Refractory Concrete—for furnace door linings, bottoms, covers, pipe linings and other types of monolithic constructions as thin as 1½". For temperatures up to 2400F.

L. W. Firecrete—Insulating Refractory Concrete—a lightweight, easily applied, low conductivity refractory for furnace bottoms, door liners, covers and special shapes of all descriptions. For direct exposure to 2400F.

*Reg. U. S. Pat. Off.

Johns-Manville BLAZECRETE*

BUILD AND REPAIR refractory linings with J-M Blazecrete. Just mix with water—flip into place and trowel smooth or, "gun" it on. Immediate firing unnecessary. Ready for use after overnight curing.

3X Blazecrete—3000F Hydraulic Setting Refractory—for heavy patching by troweling. Applied by just "flipping" into place. Also for gun application. Particularly adapted for lining ladles, runout spouts, and patching above slag line in cupolas. For soaking temperatures to 3000F.

Standard Blazecrete—Intermediate Heat Duty Hydraulic Setting Refractory—used for slap-troweling or gunning. Builds and repairs refractory linings up to 2400F.

L. W. Blazecrete—Hydraulic Setting Insulating Refractory for slap troweling or gunning—a lightweight, low-conductivity refractory designed for temperatures to 2000F. It can be used in combination with Standard or 3X Blazecrete, for special conditions.

For further information, write Johns-Manville, Box 290, New York 16, N. Y.

JOHNS-MANVILLE JM PRODUCTS

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REFRACTORY PRODUCTS

News Digest

Chalmers Manufacturing Co., passed away at the age of 82.

The Formica Co. has announced the death of *J. Roger White* after an illness of four months. Mr. White had served as vice president in charge of sales and advertising.

News of Companies

American Marietta Co., Chicago 11, has entered into the field of powder metallurgy through the purchase of approximately 52.6% of the outstanding common shares of the *Metals Disintegrating Co,. Inc.*, Elizabeth, N. J. No changes in the operating policies of Metals Disintegrating are contemplated.

A new plant for the production of calcium carbide is to be erected at Calvert City, Ky., by *Air Reduction Co., Inc.*, New York 17. It will be operated by *National Carbide Co.*, a division of Air Reduction, under the direction of Russell T. Lund. Construction of the plant is to begin July 1, with the first of the furnaces expected to be in operation by Jan. 1, 1953.

Formation of *Kropp Forge Ordnance Co.* to operate a forge plant at Melvindale, Mich., has been announced by *Kropp Forge Co.*, Chicago. Roy A. Kropp, president of Kropp Forge Co., will be chairman of the new subsidiary. Other officers include Raymond B. Kropp, president; Clifford C. Foster, vice president in charge of manufacturing; Kenneth Clark, vice president; Leo T. Norville, secretary; and Delmar Woodhouse, treasurer.

A vertical turbine pump plant is being built at Succasunna, N. J., by *Worthington Pump and Machinery Corp.*, Harrison, N. J. The plant will be known as the Succasunna Works.

Baldwin-Lima-Hamilton Corp., Philadelphia 42, has closed its offices at 120 Broadway, New York 5. All sales activities in the New York area will be coordinated in the Company's offices at 60 E. 42nd St. It was also announced that the Corporation has acquired the assets of the *Austin-Western Co.*, Aurora, Ill.

An 8,000-sq-ft addition to its plant has been announced by *Metal Carbides Corp.*, Youngstown, Ohio.

P. R. Mallory & Co., Inc., Indianapolis, and the *Sharon Steel Corp.*, Sharon, Pa., have formed a jointly-owned company to be known as *Mallory-Sharon Titanium Corp.*, for the development, production and marketing of titanium and titanium alloys. The office of the new corporation will be located initially in Indianapolis,

'Surface' WIRE ANNEALING FURNACE

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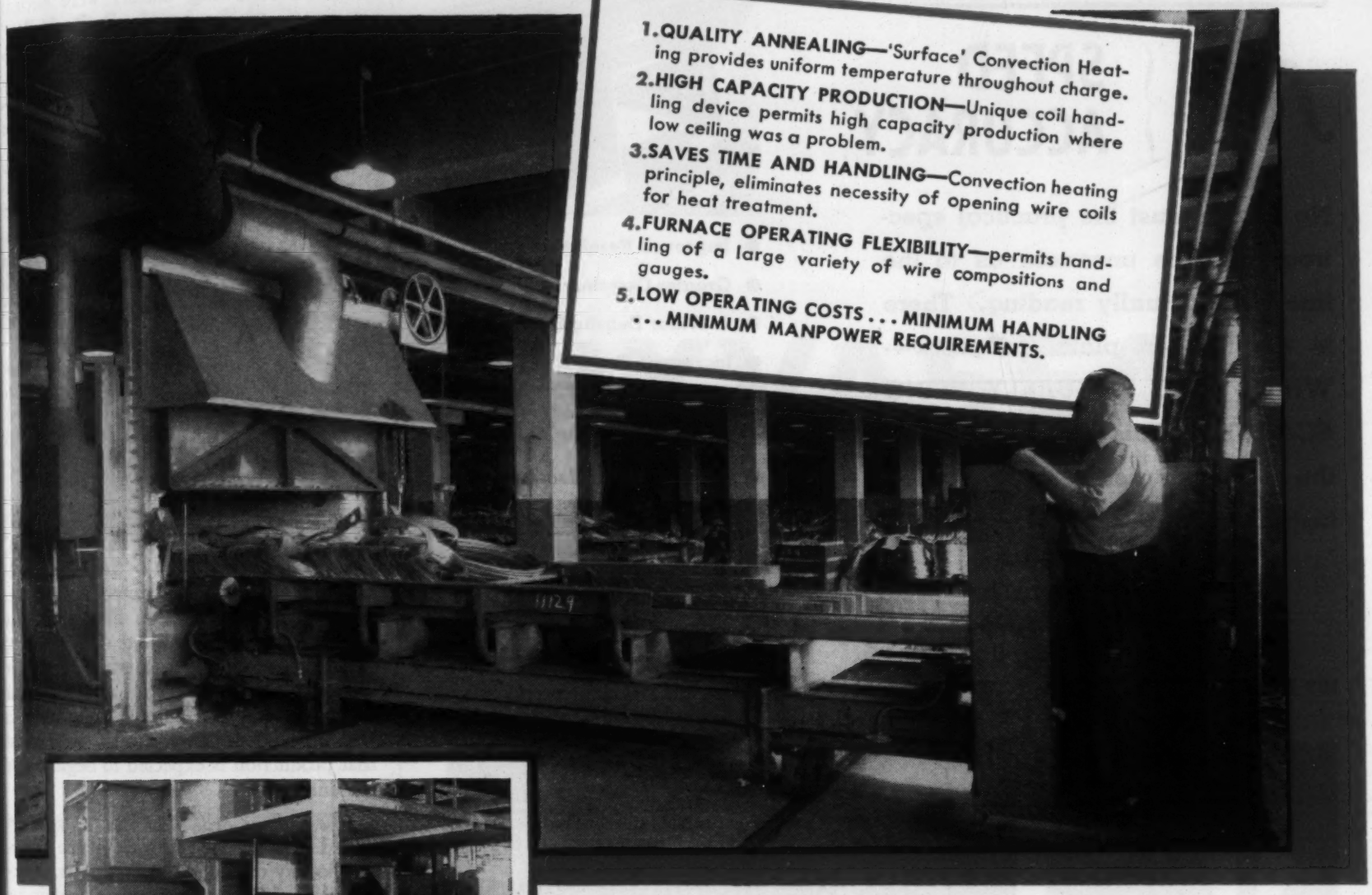

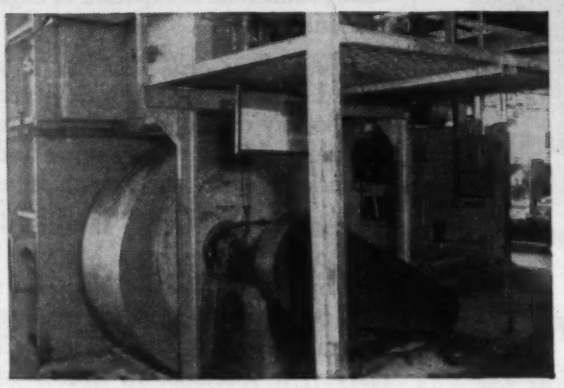

Rear view of 'Surface' Annealing Furnace showing high speed—high capacity recirculating fan used for convection heating. This assures maximum speed and uniformity of heating.

The many 'Surface' Heating Installations, whether convection heating, direct-fired or controlled atmosphere, have proved their economy in operation.

Quality heat treating, at a production rate to keep pace with high volume drawing operations, was made possible in this low-ceiling building with the use of the highly-efficient 'Surface' Convection Furnace shown above. This furnace is equipped with a unique materials handling mechanism. Non-ferrous wire coils are sling-loaded on to an alloy charging tray which is moved in and out of the furnace on roller rails.

Non-ferrous wire is heat treated at rates of 2500 lbs. net, and upwards per hour. Temperature range up to 1250°F.

This is a typical example where 'Surface' personnel worked in cooperation with company management and engineers to design heat treating equipment in keeping with plant production needs. If you have a special heat treating problem for non-ferrous or ferrous materials, for any required temperatures, it will pay you to discuss it with a 'Surface' representative. No obligation.

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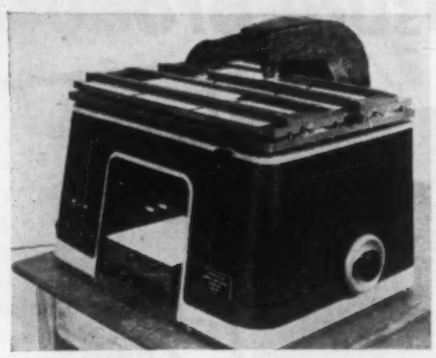

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Thermo ELECTRIC CO.
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News Digest

and the following officers were elected: chairman of the board—P. R. Mallory, president—James A. Roemer; vice president and general manager—F. H. Vandenburgh; treasurer and assistant secretary—E. N. Crosier; and secretary and assistant treasurer—George Fotheringham.

A new research laboratory is to be constructed in LeRoy, N. Y., by *Durez Plastics & Chemicals, Inc.*, North Tonawanda, N. Y. Dr. *Alvin F. Shepard*, of the present Durez research staff at North Tonawanda, will be the resident director at the new laboratory.

The world's largest single unit for manufacturing ethylene will be built at Port Arthur, Tex., by *Gulf Oil Corp.*, Pittsburgh. Production is scheduled to begin in about one year.

The development of an improved process for the commercial production of hydrogen peroxide has been announced by *E. I. du Pont de Nemours & Co. (Inc.)*, Wilmington 98, Del. Simultaneously, the firm stated it would build its first production unit at Fite Rd. and Route 51, Memphis, Tenn., at the same site where it is just starting to build a unit for the production of sodium cyanide. James J. McIntyre, who will be manager of the new plant stated that production is expected to begin before the end of 1952.

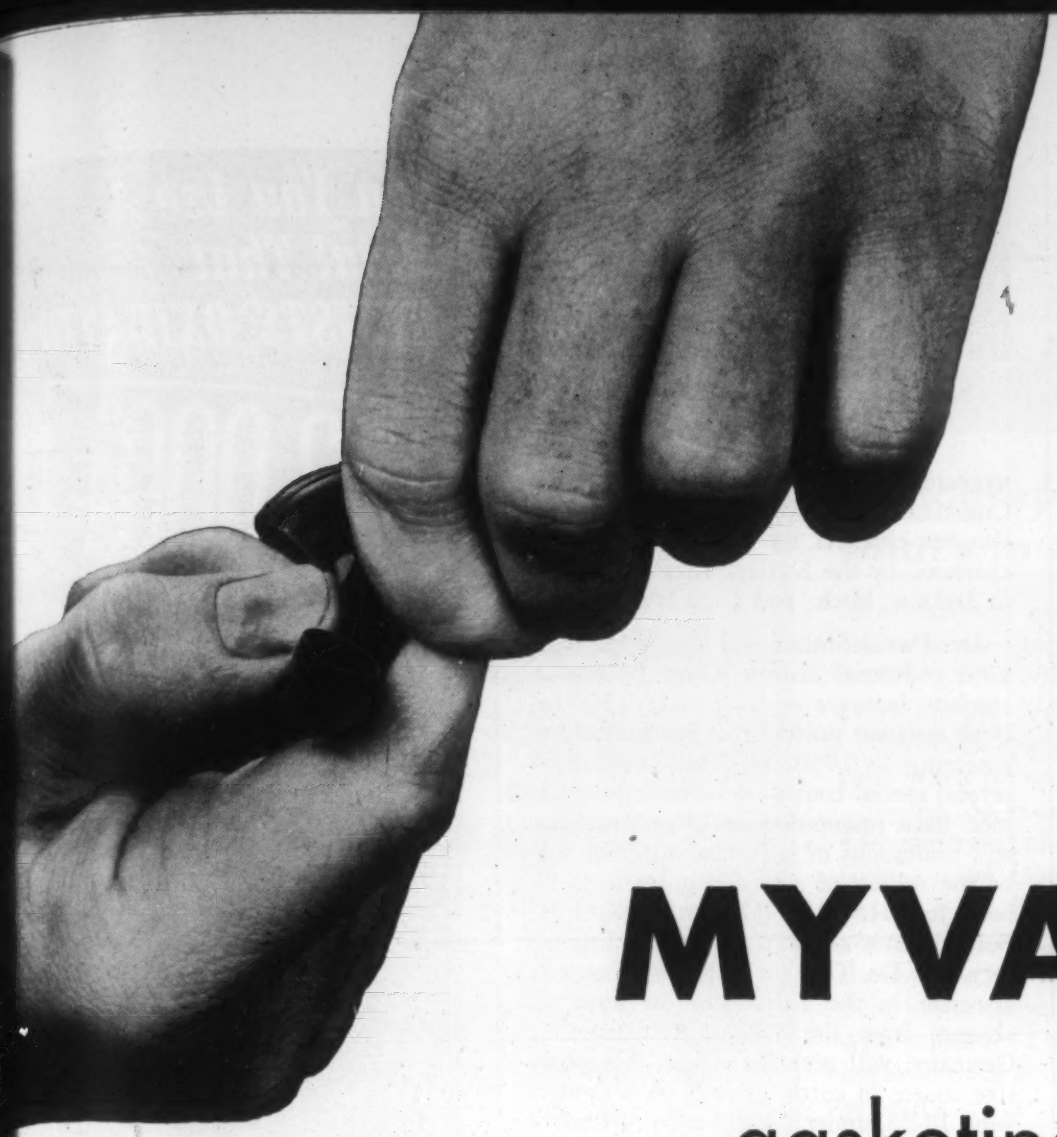
The Cory Corp., Chicago 1, was presented with the Merit Award of the American Society of Industrial Engineers, in recognition of Cory's outstanding work in engineering, research and manufacture.

Mellon Institute has announced the establishment there of a Multiple Fellowship by the *Pittsburgh Plate Glass Co.* that will be concerned with a comprehensive program on special fibers. Dr. Adelbert W. Harvey, a specialist in fibrous materials, has been appointed Senior Fellow, and will be aided by Joseph J. Reis.

The *Pennsylvania Salt Manufacturing Co.*, Philadelphia 7, has established a $300-a-year college scholarship for the children of employees of Penn Salt. One scholarship will be awarded each year.

News of Societies

The *American Society of Tool Engineers* elected new officers for the coming year at its recent annual meeting. They include: president—J. J. Demuth, Sligo, Inc.; vice presidents—L. B. Bellamy, Sterling Grinding Wheel Co.; Roger F. Waindle, Elgin National Watch Co.; and T. J. Donovan, Jr., Donovan Co.; secretary—W. A. Thomas, Ford Motor Co. of Canada; treasurer—H. C. McMillen, Seeger Refrigerator Co.; and assistant secretary-



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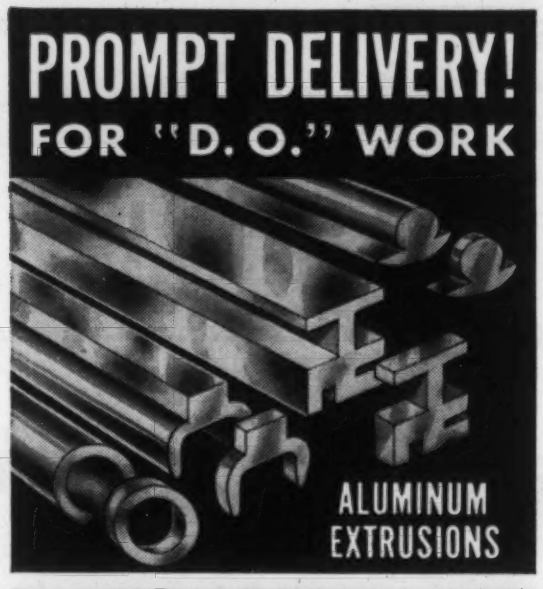

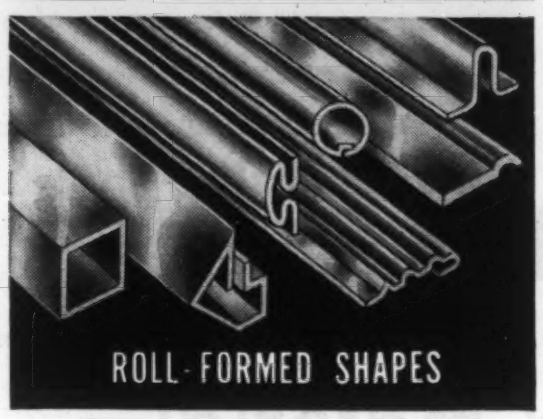

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News Digest

treasurer—Dr. H. B. Osborn, Jr., Ohio Crankshaft Co. It was also announced that two new chapters, the 87th and 88th, were chartered by the Society. They are located in Jackson, Mich., and Long Island, N. Y.

Dr. David Sinizer was appointed technical industrial liaison officer by *Massachusetts Institute of Technology*. He became assistant professor of mechanical engineering in 1950. MIT also announced several special courses to be held this summer. Basic orientation in the potentialities and limitations of industrial acoustics will be the subject of a special program to be held June 18-22, 1951. Dr. Richard H. Bolt, director of MIT's Acoustics Laboratory, and Dr. Theodor F. Hueter, research associate in the Laboratory on leave of absence from the Siemens-Reiniger Co., Germany, will give the course. An intensive course in corrosion will be presented June 18-23, under the direction of Professor H. H. Uhlig, in charge of the Institute's Corrosion Laboratory. A course on lubrication engineering is scheduled from June 11-22, with Dr. John T. Burwell, associate professor of mechanical engineering and director of the MIT Lubrication Laboratory, in charge. Metal cutting will be the subject of another course, to be held June 25 to July 6. Professors Milton C. Shaw and P. A. Smith, in charge of the machine tool laboratory of the Mechanical Engineering Dept., will be in charge. And finally, Professor John A. Hrones, director of the Dynamic Analysis and Control Laboratory, will conduct a course in the fundamentals of hydraulic power control from July 9-20.

Milton C. Whitaker received *Columbia University's* Chandler Medal for 1950, in recognition of his outstanding achievements in the chemical industry. Mr. Whitaker founded Columbia's Dept. of Chemical Engineering and at one time was in charge of it.

The *Franklin Institute Laboratories for Research and Development* has established a National Asphalt Research Center to serve the Asphalt industry in the United States. It was also announced that several changes in officers of the Institute occurred recently. Edward G. Budd, Jr., president of The Budd Co. and James H. Robins, president of the American Pulley Co., both became vice president. A. Felix du Pont, Jr. fills the vacancy on the Institute's board of managers created by the death of his uncle, E. Paul du Pont. Another new board member is Dr. James Creese, president of the Drexel Institute of Technology.

The *Illinois Institute of Technology* is the 13th engineering college to participate in the scholarship program of the Foundry Educational Foundation. The grant of $2500 provides partial scholarships for upper class students of metallurgical engineering.

★ Coated molybdenum strip undergoi laboratory life test. Life of 2500 ho at 2000°F is not uncommon.

Fansteel Siliconized Molybdenum is a entirely new material for high tempe ature service up to 3000°F. To t strength and workability of pure moly denum is added an impervious coati which resists both oxidizing and redu ing atmospheres, providing a stron electrically conductive material, co paratively abundant, reasonable in co

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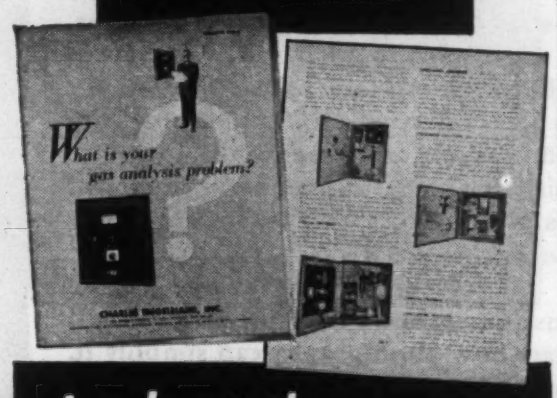

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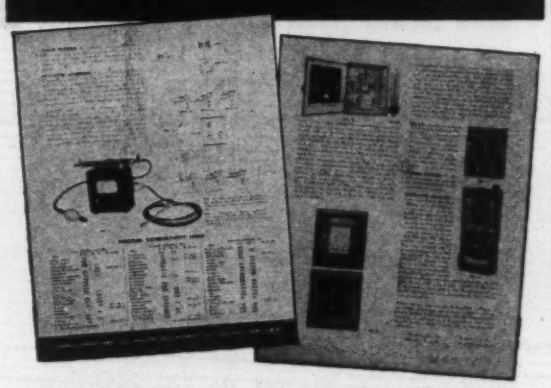

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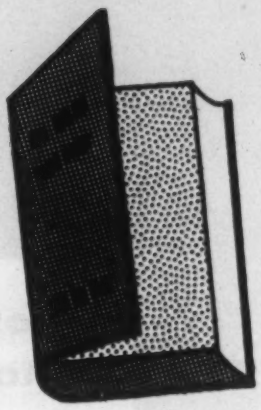

BOOK REVIEWS

Metal Polishing

INDUSTRIAL POLISHING OF METALS. *By Gerald F. Weill. Published by Iliffe & Sons, Ltd., London, England, 1950. Cloth, 5¾ by 8¾ in., 194 pages. Price 21s.*

The subject of metal polishing has been overshadowed in the technical literature by electroplating and is not generally appreciated, in the U.S.A. or in Europe, for the important process that it is.

Mr. Weill has succeeded in collecting and organizing a good cross section of the scientific and practical information on metal polishing in a handbook approach to the subject. His shop data are heavy on British practice, of course, but of a general enough nature to be of value to American engineers, especially in view of the dearth of reliable literature available at present.

The book breaks down into concise sections on history, theory, techniques, procedures, production processes and associated shop problems. None of these aspects could be covered exhaustively in the space allotted, but a good resumé is given of each, and the subject is drawn together into an overall picture that is commercially valuable to people working in the metal polishing field and of educational interest to engineers and metallurgists not directly involved.

The practical chapters are organized along the lines adopted in most metal finishing books, covering the procedures used with each important metal and nonmetal in specific detail, then going on to explain and catalogue the various polishing techniques and compositions, the mops and brushes used, the barrel processes, automatic polishing machines, electrolytic polishing, dust extraction in the shop, and cost evaluation.

The most unique chapter in Mr. Weill's book, however, and the one of most general interest, is devoted to the theory of polished surfaces, developing the subject from first principles, and explaining what a polished surface is, its properties, how it is achieved, and the methods used to test surfaces. Research information is cemented together in an interesting presentation that is worth the price of the book to many people with no practical interest in metal finishing.

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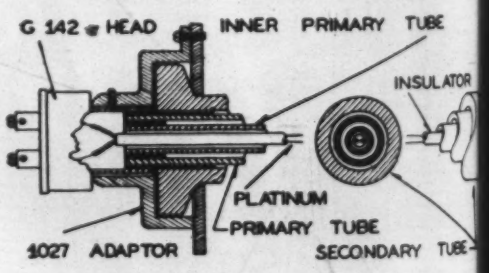

into a complete thermocouple assembly is light in weight and permits easy replacement of new elements into a protecting tube assembly.

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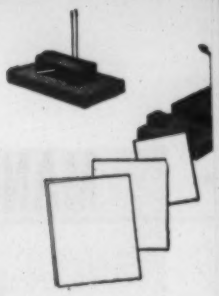

MANUFACTURERS' LITERATURE

Materials

Irons • Steels

Stainless Steel Design. Allegheny Ludlum Steel Corp. New book discusses in detail applications of high tensile stainless steel in structural design. (1)

Tool Steels. Bethlehem Steel Co. Properties, selection data and heat treating information about this company's steel. (2)

Steel Sheets and Wire. Continental Steel Corp., 20 pp, ill. Specifications and description of wide range of steel sheets and wire. Includes handy tabular aids to ordering. (4)

Stainless Steels. Peter A. Frasse & Co., Inc., No. 5. Comparative results of tests for resistance to sensitization of five extra low carbon stainless steels. (5)

High-Strength, Low-Alloy Steel. Jones & Laughlin Steel Corp., 32 pp, ill. Complete data on Otiscoloy, widely used in the transportation industry. (6)

Aircraft Steels. Joseph T. Ryerson & Son, Inc., 68 pp. Correlated Armed Forces, Federal and Aeronautical Materials Specifications plus nearest AISI analyses. Includes range of sizes and analyses available. (7)

Galvanized Steel. Sharon Steel Corp. Brochure summarizes test data on Galvanite zinc-coated steel, said to fabricate like ordinary cold-rolled steel, resist corrosion for years. (8)

Graphitic Steel. The Timken Roller Bearing Co., Steel & Tube Div. Data on properties and applications of graphitic steels in Timken Graphitic Steel Data Book. (9)

Alloy Steels. Wheelock-Lovejoy & Co., Inc., 3 pp. Data on AISI, Hy-Ten and SAE alloy steels, including composition limits, heat treating instructions, properties and applications. (10)

Stainless Clad Steel. Alan Wood Steel Co., No. D-97. Properties and applications of Permaclad stainless clad steel affording surface characteristics of stainless steel, formability of carbon steel. (11)

Nonferrous Metals

Copper vs. Corrosion. The American Brass Co., 24 pp, No. B-36. Discusses corrosion resistance of copper alloys, and includes tabular data on their resistance to 183 corrosive agents. (12)

Beryllium Copper. The Beryllium Corp. Monthly technical data on developments and applications of Berylco beryllium copper. (13)

Nickel Alloy Products. Driver-Harris Co., 4 pp, ill. *D-H Alloy Craftsman* describes various applications of nichrome and monel wires and forms. (14)

Siliconized Molybdenum. Fansteel Metallurgical Corp. Properties, advantages and available forms of siliconized molybdenum, said to give high temperature service up to 3000 F. (15)

Silicon Bronzes. Federated Metals Div., 4 pp, ill. Applications, typical properties and descriptions of high-strength silicon-copper alloys for casting. (15a)

Aluminum Alloy. Frontier Bronze Corp. Data on Frontier 40-E aluminum alloy combining high strength, good shock and corrosion resistance and machinability. (16)

Nickel-Base Alloys. Haynes Stellite Div., Union Carbide and Carbon Corp., 40 pp. Properties, specifications and uses of Hastelloy corrosion resistant grades. (17)

High Temperature Alloy. The International Nickel Co., Inc. *Keep Operating Costs Down When Temperatures Go Up* shows applications of Inconel to high temperature service. (18)

Electrical Resistance Alloy. The C. O. Jelliff Manufacturing Co. Engineering data on Jelliff Alloy 1000, said to have outstanding electrical and mechanical properties. (19)

Zinc and Zinc Alloys. New Jersey Zinc Co., 32 pp, ill. Properties, specifications and useful purchasing information on rolled zinc and Zilloy, high strength zinc alloy. (20)

Nonmetallic Materials • Parts

Porcelain Insulators. The Akron Porcelain Co., 6 pp, ill. Numerous electrical insulators of various porcelains, briefly describing engineering properties of porcelain. (21)

Felt Samples. American Felt Co., 8 pp. SAE felt standards and specifications, with samples exhibiting 16 different grades. (22)

Hard Rubber. American Hard Rubber Co., 60 pp. Manual gives detailed selection on hard rubber and plastics materials. (23)

Ceramics. American Lava Corp., 4 pp, No. 501. Detailed chart of mechanical and electrical properties of AiSiMag vitreous ceramics, lava and refractories. (24)

Extruded Plastics. Anchor Plastics Co., Inc., 8 pp, ill. Explains the forms of numerous plastic extrusions, and shows components fabricated for numerous industrial uses. (25)

Porcelain Products. The Colonial Insulator Co., 12 pp, ill. Shows wide range of custom-made porcelain products, including insulators, forms for dipped rubber goods, and kitchen appliances. (26)

Coated Fabrics. The Connecticut Hard Rubber Co. Data sheets describes heat resistant glass fabrics coated with silicone rubber. List uses, chemical, electrical and mechanical properties, and availability. (27)

Plastic Resin. Dow Chemical Co., Plastic Div., 8 pp, ill. Presents complete data on Saran, a plastic resin for injection molding. (28)

Silicone Rubber. Dow Corning Corp., No. 10. *Silastic Facts* No. 10 presents latest developments in properties, performances and applications of all Silastic stocks. (29)

Plastics. E. I. du Pont de Nemours & Co. (Inc.), 10 pp, ill, No. 113/3. Descriptions, advantages and uses of Lucite, Polythene Nylon, Butacite, Pyralin, Plastacele and Teflon. (30)

Phenolics. Durez Plastics & Chemicals Co. *Durez Plastics News* describes latest applications of this company's wide range of phenolic plastics. (31)

Metal and Plastics Parts. The Electric Auto-Lite Co., Bay Manufacturing Div., 16 pp, ill. Shows wide variety of custom-made ornamental and functional metal and plastics parts. (32)

Flexible Tubing. Flexible Tubing Corp. Bulletin shows numerous uses, featuring available sizes of Spiratube flexible tubing. (33)

Laminated Plastic Parts. The Formica Co. Catalog gives full information on company's facilities for complete machining of Formica custom-made parts. (34)

Polyvinyl Plastics. B. F. Goodrich Chemical Co., 16 pp, ill. Properties and descriptions of Geon resins for such applications as extrusions, wire and cable, flooring and molded parts. (35)

Reinforced Laminates. Laminated Plastics, Inc., 8 pp, ill. Description, properties and performance comparison of plastics, polyesters reinforced with Fiberglas for heavy duty electrical insulation. (36)

Molded Alkyd. Plaskon Div., Libbey-Owens-Ford Glass Co., 8 pp, ill, No. A-7.

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MANUFACTURERS' LITERATURE

Electrical, dimensional, chemical, resistance and design properties of molded Plaskon alkyds. Gives several case histories. (37)

Plastic Pipes and Fittings. Elmer E. Mills Corp., 4 pp, ill. Properties of Mills-Plastic corrosion resistant pipes and fittings, made for wide usage in industry. (38)

Carbon Products. Morganite, Inc., 8 pp, ill, No. 1f. Specifications of various carbon bearings and bushings. Also, properties of six series of Morganite carbon products. (39)

Nonmetallic Pipe. National Carbon Div., 16 pp, ill, No. CP-2212. Chemical resistance, properties and specifications of pipe and fittings of Karbate, phenolic impregnated carbon and graphite. (40)

Extruded and Molded Rubber Parts. Republic Rubber Div., 12 pp, ill. Describes facilities for custom manufacture of molded and extruded rubber products. Description of various products. (41)

Molded Parts. Resistoflex Corp., 4 pp, ill. No. 4g/3. Properties and uses of this company's custom-molded parts and resinous-lined, reinforced industrial hose. (42)

Plastics Parts. Rogers Corp. Booklet points out features of Fiberloy laminated and impact phenolics, vulcanized fibres and paperboards, indicating possible applications. (43)

Organic Solvents. The Solvents & Chemicals Group. Handbook describes properties and applications of key organic solvents in nontechnical terms. (44)

Sponge Rubber Parts. The Sponge Rubber Products Co., 20 pp, ill. Detailed data on grades and properties of sponge rubbers. Describes various special purpose stocks and includes specifications. (45)

Carbon and Graphite Parts. Stackpole Carbon Co., 44 pp, ill. Advantages of use of carbon and graphite in parts for frictional, temperature, electrical arcing and chemical applications. Shows large number of parts. (46)

Ceramic Laboratory Ware. The Thermal Syndicate, Ltd. Technical descriptions, specifications and prices of Vitreosil ware said to be superior to porcelain in some uses. (47)

Rubber Parts. Tyer Rubber Co., 4 pp, ill, No. 1c. Describes design and molding service for producing rubber parts specified by industry. (48)

Carbon Graphite. U. S. Graphite Co., 4 pp, ill. Describes Graphitar, carbon-graphite nonmetallic that is chemically resistant, self-lubricating, hard, light and won't warp. (49)

Latex Insulated Cables. U. S. Rubber Co. Catalog gives specifications and engineering characteristics of latex insulated telephone cables. (50)

Nonmetallic Gears. Westinghouse Electric Corp., 15 pp, ill, No. B-4661. Description and applications of Micarta gears. Includes tables of properties, gear data and preferred pitches. (51)

Metal Parts • Forms

Precision Investment Castings. The Adapti Co., 4pp, ill, No. C-2M. Close tolerances and stronger metals are among advantages listed of Adapti Method of precision casting. (52)

Precision Castings. Alloy Precision Castings Co., 8 pp, ill. Describes frozen mercury process for close tolerance precision casting of parts to order. Shows numerous products. (53)

Aluminum Products. Aluminum Co. of America, ill, No. AD-250. Folder indicates this company's research and production facilities available to prospective aluminum users. (54)

Aluminum Extruded Shapes. Aluminum Co. of America, No. AD-229. Explains potentialities of extrusion process for aluminum to save money in fabrication operations. (55)

Stainless-Clad Copper. American Cladmetals Co., 16 pp, ill. Brief description of history, manufacture, properties and applications of Rosslyn Metal, a stainless steel-clad copper. (56)

Zinc Die Castings. American Die Casting Institute. Bulletin describes Certified Zinc Alloy Plan, explaining benefits to die casting buyers. (57)

Prefinished Metals. American Nickeloid Co., 4 pp. Sampler shows finishes and platings available on zinc, steel, copper, brass and aluminum-base metals with actual samples. (57a)

Stainless Steel Parts. Amplex Manufacturing Co., 1 p, ill. Information on bearings, finished machine parts and permanent filters made from Oilite stainless steel. (58)

Precision Cast Parts. Microcast Div., Austenal Laboratories, Inc. Booklet describes Microcast process utilizing high melting alloys and producing dimensionally uniform parts. (60)

Welded Steel Tubing. Brainard Steel Co., Tubing Div., 8 pp, ill. Shows facilities for manufacturing welded steel tubing, its applications, fabrication and specifications. (61)

Magnesium Parts. Brooks & Perkins, Inc. Characteristics of, and design data on magnesium alloys. Shows examples of made-to-order parts produced. (62)

Stainless Tubing. Carpenter Steel Co., Alloy Tube Div., 4 pp, ill. Physical properties, corrosion resistance and available sizes of this company's stainless tubing. (63)

Powdered Metal Parts. Chicago Metal Products Co., 4 pp, ill. Properties and advantages of Camet custom-molded powdered metal parts. Includes design types. (64)

Steel Castings. Continental Foundry & Machine Co., 32 pp, ill. Booklet presents 12 considerations that should be taken into account in buying steel castings. (65)

Cast Monel Parts. The Cooper Alloy Foundry Co., 8 pp, ill. Reprint gives valuable data on production of cast monel and wide range of properties useful for numerous applications. (66)

Forgings. Drop Forging Assn., 60 pp, ill. Data book shows mechanical qualities of forgings, and illustrates economic, engineering and production advantages available. (67)

Die Cast Parts. The Electric Auto-Lite Co., Die Casting Div., 16 pp, ill, No. G137. Describes facilities for economical manufacture of quality die castings. (68)

Steel Tubes. Globe Steel Tubes Co. Catalog covers this company's broad line of steel tubing designed to meet all types of job requirements. (69)

Gray Iron Castings. Gray Iron Founders' Society, Inc. Booklet gives mechanical and engineering characteristics of gray iron. Includes details for designing cast components. (70)

Interlocked Die Cast Parts. Gries Reproducer Corp., 1 p., ill. Description and applications of Intercast die casting method for automatic quantity production of small, single parts or interlinked units. (71)

Precision Investment Castings. Hitchener Manufacturing Co., Inc. 6 pp, ill. Evaluates precision investment casting methods as to costs, production and properties of parts. Shows advantages of method and several applications. (72)

Die Castings. The Hoover Co., Die Casting Div. Basic information on die castings, what they are, how this company produces them to customers' specifications, and recommendations for design. (73)

Ferrous Castings. Hunt-Spiller Manufacturing Corp. Comprehensive data on properties and uses of cast iron and steel castings. (74)

Corrosion Resistant Castings. Lebanon Steel Foundry. Reference charts on types of materials available for the manufacture of castings resistant to various corrosive agents. (75)

Die Castings. Madison-Kipp Corp., 32 pp, ill. Describes company's aluminum and zinc die castings. Also shows Kipp Feather-Weight air grinder and Fresh Oil lubricators. (76)

Magnesium Parts. Magnesium Products of Milwaukee, 4 pp, ill. Briefly describes facilities for designing and producing to order magnesium and aluminum parts. Shows several products. (77)

Screw Machine Parts. Mueller Brass Co., 6 pp, ill. Shows brass, bronze and copper custom-made screw machine parts available, and lists other nonferrous products. (78)

Precious Metal Contacts. J. M. Ney Co., 2 pp, ill. Properties and applications of Ney-Oro precious metal alloys for electrical contacts. Summarizes test results on use of one such alloy. (80)

Wire Rope. John A. Roebling's Sons Co., 4 pp, ill. Advantages and features of Preformed wire ropes. (81)

Heat Resistant Parts. Rolock, Inc. Catalog

MANUFACTURERS' LITERATURE

low carbon steel, brass or stainless steel for spot and projection welding. (145)

Self-Locking Fasteners. The Palnut Co., 1 p, ill. Decribes self-locking machine screw palnuts, coil tube fasteners, shield can fasteners and acorn Palnuts. (146)

Bolts, Nuts and Studs. Pawtucket Manufacturing Co., 28 pp, No. 46. Complete price catalog of this company's fasteners of brass, bronze, stainless steel and monel. (147)

Welding Controls. Raytheon Manufacturing Co., 4 pp, ill. Principle of operation, advantages and specifications of three of this company's stored energy type welding controls. Shows applications. (148)

Mechanical Fasteners of Aluminum. Reynolds Metals Co., 2500 S. Third St., Louisville, Ky., 136 pp, ill. Detailed descriptions of such mechanical fastening methods for aluminum as metal stitching, resin bonding, riveting and nailing, their applications and advantages. Request direct from Reynolds.

Special Fasteners. South Chester Corp., Southco Div., 6 pp, ill, No. SCO-12. Descriptions and specifications of special fasteners for unique fastening applications. (149)

Carbon Arc Welding. Speer Carbon Co., 8 pp, ill. Advantages of carbon arc welding for fabricating and repairing alloy and nonferrous metals. (150)

Fasteners. Townsend Co., 12 pp, ill. Shows facilities for designing and producing all types of wire fasteners, plus numerous examples of various products. (151)

Nut Retainers. Tinnerman Products, Inc., 8 pp, ill, No. 245-3. Specifications and descriptions of Speed Grip nut retainers offering a sure method of keeping nuts secure. (152)

Forming • Casting • Molding Machining

Colloidal Graphite. Acheson Colloids Corp., 6 pp, ill, No. 425. Foundry use of colloidal graphite for preventing adherence of such surfaces as castings to molds, chills to metal, and metal to ladles. (153)

Metal Forming Process. Hydropress, Inc., 8 pp, ill, No. L-58. Detailed description of Marform process for forming accurate sheet metal parts. Applications and cost analysis included. (156)

Plastics Molding Equipment. Improved Paper Machinery Corp., 4 pp, ill. Features and advantages of Impco injection-compression, plunger, transfer and injection molding machines for plastics. (157)

Plastics Molding Press. F. J. Stokes Machine Co., 4 pp, ill, No. 503. Description and specifications for automatic plastics press. Typical products shown. (158)

Magnetic Perforating Dies. S. B. Whistler & Sons, Inc., ill. Complete descriptions and applications of this company's magnetic perforating dies. (160)

Inspection • Testing Control

Ultrasonic Equipment. The Brush Development Co., 4 pp, ill, No. F-267. Uses and specifications of Hypersonic Equipment for such uses as emulsification, dispersion and degassing. (161)

Temperature Controls. Claud S. Gordon Co., 4 pp, ill. Data on specifications and advantages of Xactline indicating and recording temperature controls. (162)

Repeated Stress Testing Machines. Krouse Testing Machine Co., 8 pp, ill, No. 46-C. Detailed description of repeated stress testing machines and accessories. Includes specifications. (163)

Temperature Controls. Minneapolis-Honeywell Regulator Co., No. 189. Specification sheet gives detailed data on features of potentiometers for controlling temperatures at several places. (164)

Universal Testing Machines. National Forge & Ordnance Co., Testing Machine Div., No. 501. Specifications, capacities and operating principle of table model universal testing machines. (165)

Universal Testing Machines. Riehle Testing Machines Div., 28 pp, ill, No. R V-4-50. Operating principles, advantages, construction features and specifications of testing machines up to 300,000-lb capacity. (166)

Tensile Testing Machines. Scott Testers, Inc., 66 pp, ill, No. 50. Shows wide assortment of testing machines for testing tensile strengths of materials, such as rubber, paper, wire and thread. (167)

Ultrasonic Tester. Sperry Products, Inc., 4 pp, ill, No. 50-105. Principle, applications, advantages and directions for using Reflectoscope in nondestructive testing of materials. (168)

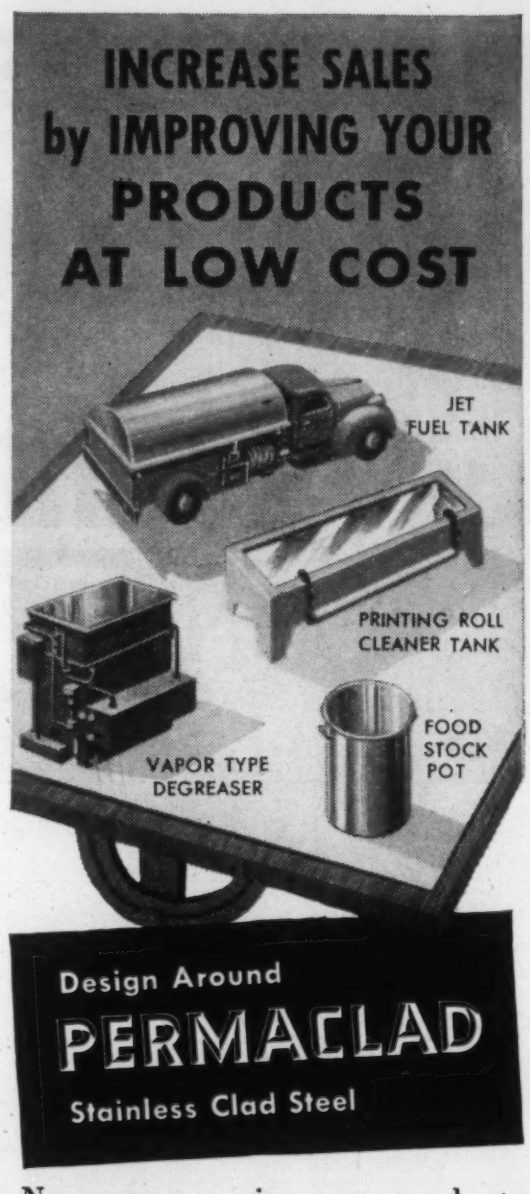
Pyrometers. Tagliabue Instrument Div., 34 pp, ill, No. 1101 J. Detailed data on Celectray thermal indicating or recording controllers and accessories designed for high sensitivity and accuracy. (169)

Pyrometer Indicators. Thermo Electric Co., No. 25 G. Catalog section describes pyrometer enabling quick temperature determination at any one of six points. (170)

General

High Vacuum Pumps. Distillation Products Industries. Data on high vacuum pumps of unique design for such uses as metal processing and dehydration. (171)

Materials Controls. Remington Rand, Inc., No. KD367. Booklet describes Kardex system for keeping visible materials and parts inventories coordinated with production. (172)



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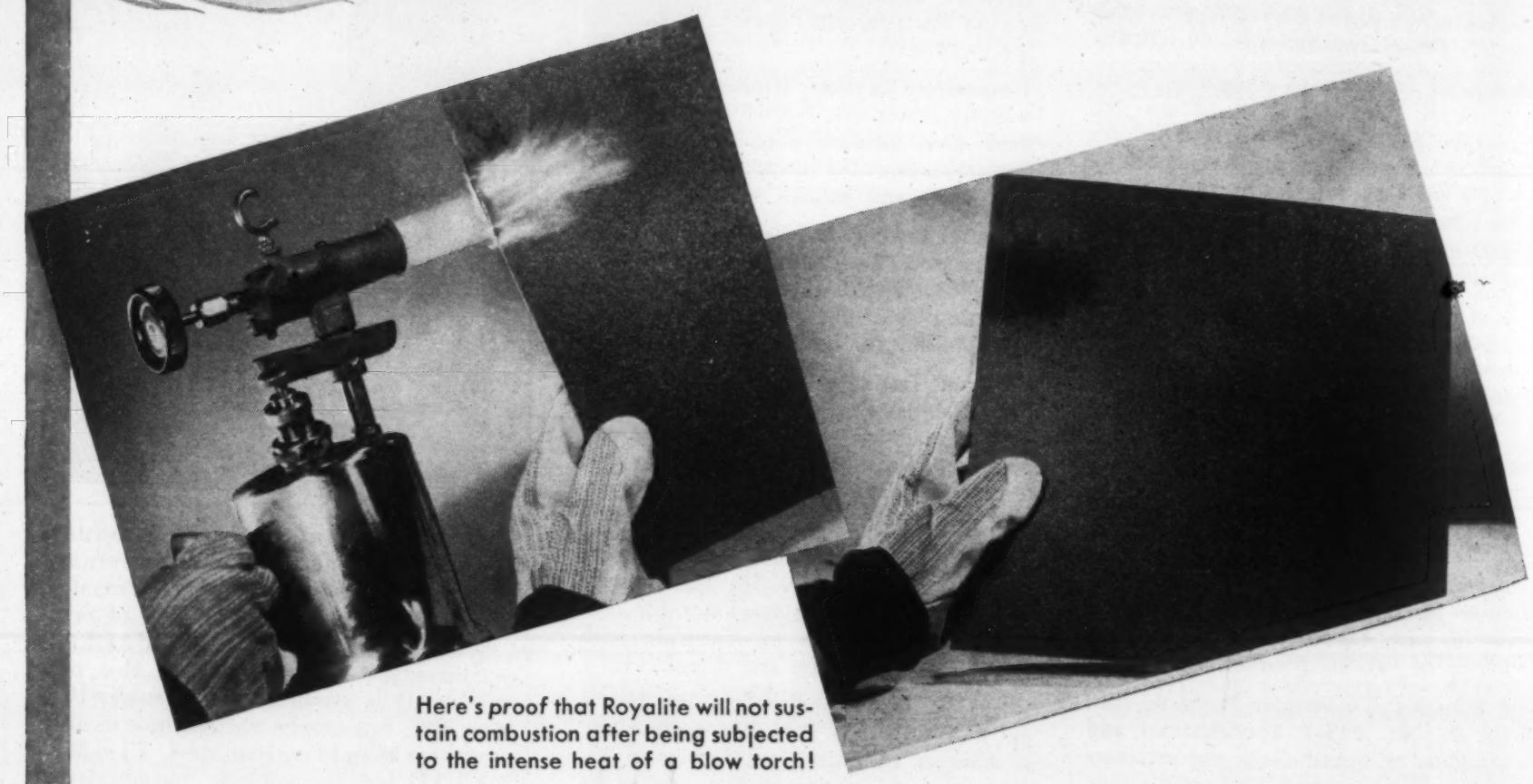

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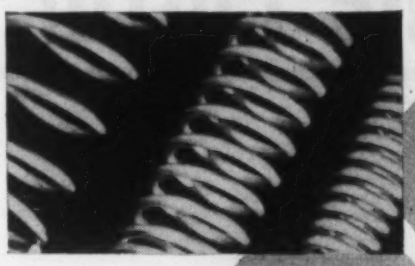

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The Editor's Page

More Skyhooks

A few months ago we mentioned on this page the subject of "skyhooks." Now we have more enlightenment on the subject from Martin E. Salmi, of Richmond, Calif. Says Mr. Salmi:

My Dear Sir:

You asked a question? Here's a reply on the "skyhooks"—To me it has always been a reality and no fun. In lumber camps when the heavy coastal fogs covered the canyons, obliterating high pole lines and cables, it was an eerie sight to an occasional tourist who would stand open mouthed when the whistle punk brought down that "skyhook" out of the fog above.

In your own city of New York, likewise, did the "skyhook" drop gently down from the fog-covered top story of your great buildings. Ask the longshoremen loading (etc.) in the dark holds of ships. Down comes that "skyhook" (and so forth).

Alas, methinks that that blankety blank thing they found in that box on the beach must have been a "skyhook." Hard work.

Help a Buddy

You realize, of course, that there are thousands of others that are plagued by materials shortages just like you are. We are going to try to help you—and them—surmount some of the attendant difficulties by means of a comprehensive article, to be published soon. If you have done any work along this line, please let us know so we can tell the world. Who knows but that by casting your bread upon the waters of mutual help you will reap a reward of many loaves of helpful information. Shoot it in fast!

What's in a Number?

Perhaps it was just an unconscious rebellion against all those big numbers coming out of Washington. Whatever the cause, in a recent issue we indicated that the import of nickel into this country was at the rate of 20,000,000 a year, which is small potatoes when even one billion is now so commonplace as to escape attention. At any rate, we are eating up nickel at a rate of 20,000,000 lb a month.

Jet-Propelled Speech

The early flash from the Capitol left us breathless. It said: "Too much hot air buckles a ceiling on capitol hill."

Knowing that the ceiling in the chamber of the House of Representatives was stainless steel, our admiration, or rather, awe of the power of our speechmakers reached a new high. Stainless steel, you know, is highly resistant to heat.

However, further details showed that the buckling was caused by an over-abundance of steam heat and not the usual hot air.

First Materials Engineer

We have been unable to learn just how long the title "Materials Engineer" has been in use. We do know that the title is now widely used and is popping up in more places than ever. We can say for sure that one of the first uses of the title on record dates back to 1920 when the Naval Gun Factory hired a man for that position. Now, materials engineering rates on a par with the other three activities of the Gun Factory's laboratory division. The others are metallurgy, chemistry and welding engineering.

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So many regular readers of MATERIALS & METHODS have suggested that our Manuals be made into a permanent form that we have decided it would be a worthwhile project. So there is now available a volume which contains all of the Manuals on materials that we have published. We can't get so commercial here as to name the price, but we can tell you that the volume will cost you a good deal less than it would if you were to buy a single reprint of the 28 chapters included.

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